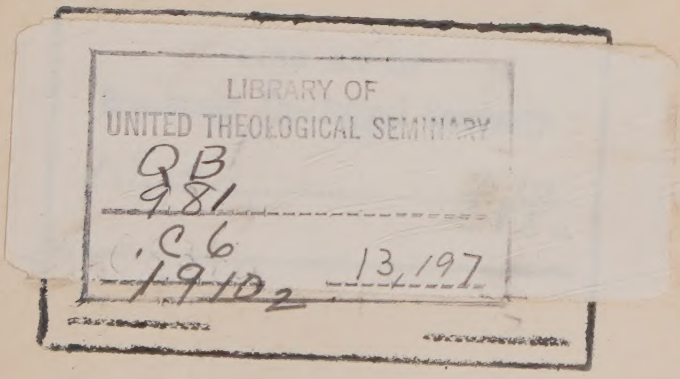
THE UNITY OF THE UNIVERSE

The Unity of the Universe

BY

JOSEPH COSAND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To

My Brothers and Sisters in all Lands

this Book is affectionately

Dedicated

FOREWORD

The civilizations and the religions of the East are built upon philosophy which does not recognize the existence of Diety; and in the West, among Christian peoples, the anti-Deistic philosophy of evolution has caused an apparent conflict between science and religion, so that many honest people are unable to understand truth from error.

In Japan, both the Eastern and Western materialistic philosophies are taught, and thus seeds are sown which directly oppose a belief in God as Creator, and in the immortality of man. The Christian teacher in the East has constantly to meet and counteract one form or another of materialistic belief.

A few years ago when temporarily confined by illness my mind became intensely absorbed in meditation on the existing conditions in Christian and non-Christian lands, and I was painfully aware of the great gulf seemingly fixed between those who follow materialistic philosophy, under whatever name, and those who believe the Gospel as taught by Jesus Christ. Then it seemed to me that a common meeting ground for all men could be found only through a better scientific knowledge of the constitution of matter and the relation of the physical universe to the spiritual realm, and that the acquisition of this knowledge could not be realized without an understanding of the principles involved in the mysterious law of gravitation. Therefore, trusting in God for guidance, I began study, continuing

through the intervening years, which has resulted in the production of this volume.

It makes no great pretension to scientific discovery, but is largely a compilation of scientific and religious facts already known, and now, for the first time, so brought together as to show a unity in the physical and spiritual universe heretofore unobserved. From a scientific adjustment of physical phenomena I have been led to see that the data available demonstrate conclusively the nature of the constitution of matter, including gravity, and that the true gravitative principle is found in the Archimedean law rather than in that of Newton. Such a knowledge of matter leads back to a Creator and forward to faith in God as revealed in Jesus Christ, because the Physical Realm has thus become an image of the Spiritual Realm, and God is seen in His two-fold manifestation—in the things He has made, and in the things He has revealed.

The book may not be found to be as easy reading as a light story, but I hope that those who are deeply interested in the scientific and religious progress of the world may find both profit and pleasure in a careful study of its pages. With an earnest prayer that it may be a blessing to many I send it forth.

Several persons of learning, both in America and in Japan, have kindly assisted in supplying material, and in offering suggestions and criticisms, all of which have been very helpful and highly appreciated. To all these I acknowledge my great obligation, and extend to them my heartfelt thanks.

Tokyo, June 1, 1910. Joseph Cosand.

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The Unity of the Universe

Part I

The Physical Realm

Chapter I

Unscientific Philosophy

The foundation of Chinese philosophy was laid by the emperor Fukkishi, who lived more than four thousand years ago. He wrote a book called the "Eki," in which he set forth a philosophy comprising eight parts called the "Hakke." Fukkishi's philosophy was too difficult to be easily understood by any but the sages, several of whom assayed to interpret its meaning. Both Lautsz, the founder of Taoism, and Confucius, the great philosopher, built their systems largely on the teachings of the "Eki."

According to the Chinese philosophy, heaven and earth were produced from "Yū" (有), which means something as opposed to nothing. "Yū" was produced or evolved from "Mu" (無), which means nothing, non-existence. Consequently nothingness was the source of all things.

From "Yū" there came the "Inyō," the Chinese female and male principles. "In" is the inferior principle and stands for stillness, sterility, darkness, submission, autumn, winter, west, north, moon, and earth. "Yō" is the superior principle and is the opposite of "In," the female principle. It represents clearness, openness, elevation, strength, benevolence, heaven, light, spring, summer, east, south, lord, husband and man.

Whilst India does not seem to have had a philosophy so well systematized as that of China her philosophical ideas, when reduced to their essence, lead to the same end—a beginning of creation from nothingness. The earlier philosophy of India is reflected in the teaching of Guatama—Buddha. Previous to his birth the philosophy of the age no longer taught the immortality of the soul. In consequence of a belief in the transmigration of soul all thought that their sufferings in this life were the result of their evil deeds in a former state of existence, and they looked for release from pain in a complete extinction of individual being.

After Guatama left his home to become a religious mendicant he attached himself successively to two Brahman sophists, one named Atara and the other Udraka, from whom he learned all that Indian philosophy could teach. For years

he had looked at the world through the medium of a philosophy which taught that life contained only evil and was altogether vanity. Therefore, later, when he conceived himself to be the Buddha, the Enlightened One, he seems to have made these philosophical ideas the basis for his doctrine of Nirvana.

The philosophy of Buddhism does not, like that of China, attempt to solve the problem of the ultimate origin of creation in a direct manner; but starting with the material world and conscious beings in it as a basis it reasons backward to Nirvana which appears to antecede the cosmos. The ideas of the utter vanity of all earthly good and the inevitable law of rebirth make life an evil and death itself no deliverance from it. In order, therefore, to escape from the misery of life it is necessary to go back of corporeal things to the source or seed. This is found in "Karma," which is defined as "the sum of merit and demerit." Life from the seed Karma always being evil, including the whole of the material world, the demerits of living beings are greater than their merits. Thus the only way to obtain release is by destroying the seed. This can be attained only by following the "fourfold path" of Buddhism. He who does this can enter Nirvana at once—the place of rest and peace through freedom from life by

absorption into Philosophical Nothingness. Nirvana seems to be almost synonymous with the Chinese Mu, previously explained.

Indian Buddhism teaches that every thing is subject to the law of cause and effect. This bears a close resemblance to the Chinese philosophy of the male and female Principles—positive and negative principles which act and react on each other.

The Chinese philosophy of the male and female principles and the Indian philosophy of cause and effect not only have much in common with each other, but also with modern science, as we now know that all physical systems are maintained by the equalization of the kinetic and the potential energies operating in them—two opposing forces. But the pre-cosmic Mu and Nirvana, out of which, in some mysterious manner, heaven and earth came are wholly unscientific, and the superstructures built upon the Inyō and the Karma are monstrously erroneous.

During many centuries these closely related philosophical systems have formed the basis of the civilizations and the religions of half the peoples of the globe, but before the advance of modern scientific and religious knowledge they must ere long lose their power.

By the inertia of matter it is known that the energy in matter and of which the different forms of matter are but so many physical expressions is superior to matter and pre-existent.

Also through the operation of the law of the equality of action and reaction it is demonstrated that, though the form of the energy may change, energy is indestructible. A given amount of energy, when applied, always produces an amount of energy equal to itself—no more and no less. Consequently, energy did not come from nothing and it cannot go into nothing. It is eternal.

Perhaps few in the West would appreciate that part of the Eastern philosophies which implies that all things have been evolved from nothing. Scarcely any one would stop to reflect upon a theory which involves so great a stretch of the imagination, yet some of the philosophic and religious opinions prevalent in the West are not much in advance of the speculations of the ancient Chinese and Indian philosophers.

The ideas which many men in Christendom have of the creation is that God created matter, and consequently the physical universe, from nothing. It need scarcely be said that such a conclusion is without foundation, either in nature or revelation, and when carefully considered is seen to be without reason. We have already remarked that matter, being inert, acts only when

acted upon. It cannot originate motion, or energy. It only trasmits motion. No material energy has ever been discovered by science which had not been derived from an adequate source. Physical energy is conserved by the law of reaction. All energy expended finds a resting place in some substance and is temporarily retained as potential energy or transmitted in some form of kinetic energy. If energy could find a perpetual resting place in vacuity apart from substance, there could never be any reaction and the energy would be lost or destroyed. Nothingness and vacuity are synonymous. These, in an absolute sense, contain no substance, no energy, either spiritual or physical; and the proposition that any thing could be produced from a vacuum is quite unthinkable and opposed to every known law. All scientific data point to a Great Ultimate Spiritual Source as the origin of the material universe: but even Infinity could not produce something from nothing.

If no power in the universe can get energy from a vacuum we are by this position led on to another, namely, can one body exercise energy on another body when a vacuum exists between them? The mists which have been cast over this important question of our time have helped to inculcate a sentiment in the West which is but little short of superstition.

It is a matter of common observation that the several bodies of the solar system, and of all similar systems, attract and repel one another. In regard to this influence of one body over another when the two are widely separated there is the Theory of Attraction "at a distance." It is based on the assumption that bodies attract one another across vacuums of great extent, or, over immense distances without the aid of any intervening medium. The advocates of this view hold that matter is so constituted that it has this power inherent in itself.

The Grecian philosopher, Epicurus, taught that "All that exists is corporeal; the intangible is non-existent or empty space. The fundamental postulates of Epicureanism are atoms and the void." This involves the necessity of there being an inherent principle in matter capable of influencing bodies over vast distances void of an intervening medium. Although more than two thousand years have elapsed since the days of Epicurus the world has not gotten away from his philosophy. To-day the vague and indefinite idea that the planets are out in space, moving around the sun because impelled thereto by nothing but an unknown something called attraction, exercised over an immeasurable void, by inanimate matter, lingers in the minds of many of even the most scholarly men.

Professor Maxwell says, * "There has been a great deal of speculation as to the cause of such forces, one of them, namely, the pressure between bodies in contact, being supposed to be more easily conceived than any other kind of stress. Many attempts have therefore been made to resolve cases of apparent attraction and repulsion at a distance into cases of pressure. At one time the possibility of attraction at a distance was supposed to be refuted by asserting that a body cannot act where it is not, and that therefore all action between different portions of matter must be by direct contact. To this it was replied that we have no evidence that real contact ever takes place between two bodies, and that, in fact, when bodies are pressed against each other and in apparent contact, we may sometimes actually measure the distance between them, as when one piece of glass is laid on another, in which case a considerable pressure must be applied to bring the surfaces near enough to show the black spots of Newton's rings, which indicates a distance of about a ten thousandth of a millimeter."

Newton, in his *Principia*, by strict dynamical reasoning deduced from the observed motions of the heavenly bodies the Theory of Attraction, but he says nothing there about the causes

* Encylcopedia Britannica, Vol. III, p. 63. (American Edition).

which produce gravitation. We know, however, that he did not believe matter possessed the power of attraction and repulsion at a distance. In a letter to Bentley he wrote, "It is inconceivable that inanimate brute matter should, without the mediation of something else which is not material, operate upon and affect other matter without mutual contact, as it must do if gravitation in the sense of Epicurus be essential and inherent in it. That gravity should be innate, inherent, and essential to matter, so that one body can act upon another at a distance, through a vacuum, without the mediation of any thing else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it."

The physical sciences, during the past two hundred years, have made wonderful progress, and in every instance where the knowledge gained touches the law of attraction it bears out the correctness of Newton's conviction that to hold that gravity should be innate, inherent and essential to matter, so that one body can act upon another at a distance, through a vacuum, is a great absurdity.

Heat, light, electricity and sound, are all conveyed from one body to another through the mediation of æther and atmosphere. Every known force in nature which has hitherto been accounted for, has been ascertained to be caused by contact of matter with matter either directly or through a medium. It is only reasonable, therefore, to seek for the cause of gravitation along the path which science has already marked out for us; namely, that of matter in contact with matter.

Prof. Lodge says:* "Now, if there is one thing with which the human race has been more conversant than another, and concerning which more experience has been unconsciously accumulated than about almost any thing else that can be mentioned, it is the action of one body upon another; the exertion of force by one body on another, the transfer of motion and energy from one body to another, any kind of effect, no matter what, which can be produced in one body by means of another, whether the bodies be animate or inanimate."

When we appeal to this mass of experience are we not justified in saying that the direct action of one body on another across empty space is wholly unthinkable? Upon due consideration it will be apparent, I think, "That whenever one body acts on another body by

* Modern Views of Electricity, p. 33.

obvious contact, we are satisfied and have a feeling that the phenomenon is simple and intelligible, and that, whenever one body apparently acts on another body at a distance we are irresistibly impelled to look for the connecting medium." If this is so the philosophy of attraction at a distance must be unsound. This we maintain, and, as our treatment of physical phenomena progresses we shall hope to show, that a reasonable cause for the seeming attraction at a distance is within sight. A clearer understanding of the constitution of matter will a d us in arriving at a better knowledge of the law of gravitation, and this will constitute a great step towards a fuller comprehension of the creation and from whence came the living creatures upon the earth.

Chapter II.

Present Tendency of Scientific Thought Concerning Attraction.

In Chapter I it was shown that Sir Isaac Newton did not believe that attraction was possible, between bodies widely separated, without the aid of an intervening medium. In Maclaurin's account of Newton's discoveries we find the following:

"It appears from his letters to Boyle, that this was his opinion early, and if he did not publish it sooner it proceeded from hence only, that he found he was not able, from experiment and observation, to give a satisfactory account of this medium and the manner of its operation in producing the chief phenomena of nature."

Prof. J. Clerk Maxwell sums up the opinions of Newton, Faraday, and other writers on the phenomenon of attraction in the following language: * "In his (Newton's) Optical Queries, indeed, he shows that if the pressure of this medium is less in the neighborhood of dense bodies than at great distances from them, and that if the diminution of pressure is inversely as the distance from the dense body, the law will be that of gravitation. The next step, as he points out, is to account for this inequality of pressure in the medium; and as he was not able to do this,

* Encyclopedia Britannica, Vol. III, p. 64.

he left the explanation of the cause of gravitation to succeeding ages. As regards gravitation the progress made towards the solution of the problem since the time of Newton has been almost imperceptible. Faraday showed that the transmission of electric and magnetic forces is accompanied by phenomena occurring in every part of the intervening medium. He traced the lines of force through the medium; and he ascribed to them a tendency to shorten themselves and to separate from their neighbors, thus introducing the idea of stress in the medium in a different form from that suggested by Newton; for whereas Newton's stress was a hydrostatic pressure in every direction, Faraday's is a tension along the lines of force, combined with a pressure in all normal directions. By showing that the plane of polarization of a ray of light passing through a transparent medium in the direction of the magnetic force is made to rotate, Faraday not only demonstrated the action of magnetism on light, but by using light to reveal the state of magnetization of the medium, he 'illuminated,' to use his own phrase, 'the lines of magnetic force.'

"From this phenomenon Thomson afterwards proved, by strict dynamical reasoning, that the transmission of magnetic force is associated with a rotary motion of the small parts of the medium.

He showed, at the same time, how the centrifugal force due to this motion would account for magnetic attraction.

"A theory of this kind is worked out in greater detail in Clerk Maxwell's Treatise on Electricity and Magnetism. It is there shown that, if we assume that the medium is in a state of stress, consisting of tension along the lines of force and pressure in all directions at right angles to the lines of force, the tension and the pressure being equal in numerical value and proportional to the square of the intensity of the field at the given point, the observed electrostatic and electromagnetic forces will be completely accounted for.

"The next step is to account for this state of stress in the medium. In the case of electromagnetic force we avail ourselves of Thomson's deduction from Faraday's discoveries stated above. We assume that the small parts of the medium are rotating about axes parallel to the lines of force. The centrifugal force due to this rotation produces the excess of pressure perpendicular to the lines of force. The explanation of electrostatic stress is less satisfactory, but there can be no doubt that a path is now open by which we may trace to the action of a medium all forces which, like the electric and magnetic forces, vary inversely as the square

of the distance, and are attractive between bodies of different names, and repulsive between bodies of the same names.

"The force of gravitation is also inversely as the square of the distance, but it differs from the electric and magnetic forces in this respect, that the bodies between which it acts cannot be divided into two opposite kinds, one positive and the other negative, but are in respect of gravitation all of the same kind, and that the force between them is in every case attractive. To account for such a force by means of stress in an intervening medium, on the plan adopted for electric and magnetic forces, we must assume a stress of an opposite kind from that already mentioned. We must suppose that there is a pressure in the direction of the lines of force, combined with a tension in all directions at right angles to the lines of force. Such a state of stress would, no doubt, account for the observed effects of gravitation. We have not, however, been able hitherto to imagine any physical cause for such a state of stress. It is easy to calculate the amount of this stress which would be required to account for the actual effects of gravity at the surface of the earth. It would require a pressure of 37,000 tons weight on the square inch in a vertical direction, combined with a tension of the same numerical

value in all horizontal directions. The state of stress, therefore, which we must suppose to exist in the invisible medium, is three thousand times greater than that which the strongest steel could support....

"Sir William Thomson has shown that if we suppose all space filled with a uniform incompressible fluid, and if we further suppose either that material bodies are always generating and emitting this fluid at a constant rate, the fluid flowing off to infinity, or that material bodies are always absorbing and annihilating, the deficiency flowing in from infinite space, then, in either of these cases, there would be an attraction between any two bodies inversely as the square of the distance....

"Dr. Robert Hooke, a man of singular inventive power, in 1671, endeavored to trace the cause of gravitation to waves propagated in a medium. He found that bodies floating on water agitated by waves were drawn towards the centre of agitation....

"Professor Challis has investigated the mathematical theory of the effects of waves of condensation and rarefaction in an elastic fluid on bodies immersed in the fluid. He found the difficulties of the investigation to be so great that he has not been able to arrive at numerical results. He concludes, however, that the effect

of such waves would be to attract the body towards the centre of gravitation or to repel it from that centre, according as the wave's length is very large or very small compared with the dimensions of the body. Practical illustrations of the effect of such waves have been given by Guyot, Schellback, Guthrie, and Thomson.

"A tuning fork is set in vibration, and brought near a delicately suspended light body. The body is immediately attracted towards the tuning fork. If the tuning fork is itself suspended it is seen to be attracted towards any body placed near it. Sir W. Thomson has shown that this action can in all cases be explained by the general principle that in fluid motion the average pressure is least where the average energy of motion is greatest. Now the wave motion is greatest nearest the tuning fork, the pressure is therefore least there ; and the suspended body being pressed unequally on opposite sides, moves from the side of greater pressure to the side of less pressure, that is towards the tuning fork. He has also succeeded in producing repulsion in the case of a small body lighter than the surrounding medium."

Another theory of gravitation is that propounded by Le Sage, of Geneva. He concluded that the gravitation of bodies towards each other was caused by the impact of atoms of

matter flying in all directions through space. A body placed by itself in space would be acted upon equally on all sides by the moving atoms, but two bodies some distance apart would partially shield each other on their sides facing each other and consequently be drawn nearer together.

We see in the foregoing paragraphs three theories of gravitation advanced—that of the generation or absorption of fluid, that of waves in a fluid, and that of ultramundane corpuscles. All of these hypotheses agree in seeking to account for attraction by an intermediate fluid, or an atomic substance, but each alike involves a constant expenditure of energy for which there appears to be no source of supply. Neither can, therefore, be regarded as a satisfactory explanation of the cause of gravitation.

Other instances could be cited showing that many leading scientists have looked hopefully forward to a time when gravitation would be fully accounted for through some kind of energy phenomenon in an intermediate substance. Such was Newton's conviction, because he saw that such was the only reasonable path open to investigation. His own idea that this fluid might be more dense at great distances from celestial bodies than it is near them was doubtless wrong as it seems to be opposed to scientific data, but

he was, nevertheless, pursuing a fruitful line of investigation.

The deep mystery in which gravitation has always been shrouded, since the discovery of the law, is, I believe, one reason why the facts concerning its cause have been so difficult to ascertain. For instance, has not the difference between the electromagnetic strain, discovered by Faraday, and the gravitation strain been made to appear too great? True, gravity knows no polarity like electromagetism, but there are other phenomena common to both which indicate a close relationship. In both, the forces vary inversely as the square of the distance, and they agree in one other very important respect, namely; that of attraction when a body being acted upon by another body is surrounded by a fluid of less susceptibility or density than the body itself and of repulsion when the reverse is the case. In the chapter on "Paramagnetic and Diamagnetic Bodies" it will be shown that a body is attracted to a magnet when the medium surrounding it is less susceptible to magnetic influence than the body acted upon by the magnet, but when the body is less magnetic than the fluid constituting its environment it is repelled. A similar law operates in gravitation. If the earth be the attracting body, another body, according to circumstances, may be either

attracted or repelled. A drop of water when expanded by heat until it becomes less dense than the atmosphere is repelled by the earth, but when, in the upper regions, it is condensed by cold it falls straight to the earth, because it is more dense than the air enveloping it. Here are coinciding phenomena which, if traced to their ultimate sources, may show a close relationship existing between each other and also demonstrate more clearly what the forces of electromagnetic and gravitation phenomena are, especially the latter.

In the attempt to demonstrate the physical cause of gravitation it will be necessary to find a medium whose properties and motions shall be able to account for all the movements of the heavenly bodies as now known to us. It has already been shown that such a medium is required and anticipated in the scientific world. Moreover, the writer believes that such a medium is found in the æther which we know to be the agent of the transmission of heat, light, and electricity. This feeling is rendered more apparent by the statement of Professor Glazebrook, in his work on J. Clerk Maxwell. He says: "We are still waiting for some one to give us a theory of the æther, which shall include the facts of electricity and magnetism, luminous radiation, and it may be gravitation."

Chapter III

Aether

Many philosophers, from Plato down to the present time, for numerous reaso s have maintained the hypothesis that some kind of æther exists throughout space. Descartes was probably the first who attempted to formulate a systematic theory of the constitution of matter with an all-surrounding æther. But it was not until the latter part of the seventeenth century that scientists had any positive evidence of the existence of æther. All, previous to that time, had been mere speculation; but Huygens, acting on a suggestion made by Hooke that the propagation of light was due to waves in æther, set himself to prove whether this was so or not. He was entirely successful in demonstrating that light is propagated by means of waves, and "the evidence for the existence of luminiferous æther has been accumulating as additional phenomena of light and other radiations have been discovered; and the properties of this medium, as deduced from the phenomena of light, have been found to be precisely those required to explain electromagnetic phenomena."

The proof that light is not a substance is contained in the phenomenon of interference. By the use of certain optical instruments a

beam of mono-chromatic light from a single source may be divided into two parts, and after traveling through different paths of unequal distance by half a wave length or any odd multiple of half wave lengths, may be again united and made to fall on a screen. When one half of the beam of light falls on the screen it illuminates it, but when both halves fall upon it the screen becomes dark. This shows that these two rays of light of unequal length coming into contact annihilate each other. This is explained by the doctrine of interference advanced by Dr. Young. The law discovered by him proves the existence of waves in the æther which is the medium of the propagation of light. Dr. Young, writing of his discovery, lucidly explains the phenomena of interference as follows:

* "It was in May 1801 that I discovered, by reflecting on the beautiful experiments of Newton, a law which appears to me to account for a greater variety of interesting phenomena than any other optical principle that has yet been made known. I shall endeavor to explain this law by a comparison.

"Suppose a number of equal waves of water to move upon the surface of a stagnant lake, with a certain constant velocity, and to enter a narrow channel leading out of the lake. Suppose then another similar cause to have excited another

* Works, Vol. I, p. 202.

equal series of waves, which arrive at the same channel, with the same velocity, and at the same time with the first. Neither series of waves will destroy the other, but their effect will be combined: if they enter the channel in such a manner that the elevations of one series coincide with those of the other, they must together produce a series of greater joint elevations; but if the elevations of one series are so situated as to correspond to the depressions of the other, they must exactly fill up those depressions, and the surface of water must remain smooth; at least I can discover no alternative, either from theory or from experience.

"Now I maintain that similar effects take place whenever two portions of light are thus mixed; and this I call the general law of the interference of light. I have shown that this law agrees, most accurately, with the measures recorded in Newton's Optics, relative to the colors of transparent substances, observed under cirsumstances which had never before been subjected to calculation, and with a great diversity of other experiments never before explained."

Scientists having demonstrated conclusively that a tenuous substance called æther is present in interplanetary space and that one of its functions is the transmission of energy by means

of luminiferous waves it is next in order to examine the nature of this medium.

In the first place it is capable of receiving and transmitting energy by radiations. Spectroscopic examination shows that these radiations contain not only waves of light but also those of heat and electricity. Any of these waves are evidence of work being done. This energy may be calculated by measuring the heat thus communicated to absorbing bodies. The energy is not communicated instantaneously from the radiating body to the absorbing body, but is retained awhile in the æther.

* "If we adopt either Fresnel's or Maccullagh's form of the undulatory theory, half of this energy is in the form of potential energy, due to the distortion of elementary portions of the medium, and half in the form of kinetic energy, due to the motion of the medium. We must therefore regard the æther as possessing elasticity similar to that of a solid body, and also as having a finite density."

According to calculations based upon Pouillet and Thomson's observations of the force of the sun's radiations the density of the atmosphere at an infinite distance from the earth, when there is a uniform temperature at the earth of 0°c, has been estimated to be 3×10^{-643} and that of the æther in the same region as 3×10^{327}

* Maxwell, Encyclopedia Britannica, Vol. VIII, p. 670.

times greater than that of the air. More recent calculations by others have estimated the density of the æther to be much greater than that based upon the measurements of the earlier scientists. If we accept even the more conservative estimate the density of the æther is very considerable.

Prof. Tyndall, writing on the varying density of æther says * "The density of the æther is greater in liquids and solids than in gases, and greater in gases than in vacuo. A compressing force seems to be exerted on the æther by the molecules of those bodies."

Professor Challis, of Cambridge, in the Philosophical Magazine of June, 1872, wrote on the elasticity and density of æther as follows: "I assume that all the active forces of nature are different modes of pressure under different circumstances of a universal elastic æther, which presses always proportionately to its density."

Writing of the luminiferous and the magnetic media, based upon experiments made by himself, J. Clerk Maxwell wrote, "The elasticity of the magnetic medium in air is the same as that of the luminiferous medium, if these two coexistent, coextensive, and equally elastic media are not rather one medium."

The very rapid motion of the æther distinguishes it from gross matter. There are from forty

* Lectures on Light.

to sixty-nine thousand waves to the inch in a beam of light which act with such amazing rapidity that light travels at the rate of 186000 miles in one second of time. This is about a million times faster than the velocity of the normal vibrations of the air. It is therefore evident that the æther, the medium of light, is not the gross matter called air. It is a substance more electric in its motion and in its constitution. As previously intimated by J. Clerk Maxwell the properties of the medium of light seem to be similar in all respects to those of the electromagnetic medium. The velocity of electromagnetic disturbances through different media is essentially the same as that of the propagation of light through the same substances. Various sets of data, gathered from different sources, show that an electromagnetic disturbance in air does not differ more from the velocity of light in air than the several calculated values of these quantities differ among each other. The same is true also of the gases, and so far as experimental verification has been possible similar results have been obtained from liquids and solids.

The physical constitution of the æther will be dealt with in succeeding chapters in connection with the constitution of matter in general, but a few words must be said here about its atomicity and its gravitative qualities. Sir

W. Thomson has demonstrated that the magnetic influence on light depends on the direction of motion of moving particles, and that these particles have rotational motion in the medium when magnetized. This must be a rotation of very small portions of the medium, each about its own axis, "so that the medim must be broken up into a number of molecular vortices."

A subject which has claimed the attention of scientific specialists more than almost any other is whether æther is gravitative. Do bodies of dense matter like the earth and the sun, when in motion, carry along with them the æther, or do they glide through it without perceptibly disturbing it? One hypothesis is that the atoms of the æther are so small that they glide through the interstices of solids without much interference, like the wind passes through the branches of trees; and another is that the aether is frictionless and slips around solid bodies without being held to them by attraction. If either of these theories be true the æther is inconformable to Newton's law of gravitation. Experimental investigations indicate that the earth carries the æther along with it; but to accept such a conclusion makes æther subject to gravity, and imparts to it the property of friction which seems to interfere with the Newtonian theory that the heavenly bodies move through space

unobstructed by any intervening medium. A preponderance of evidence however leads to the belief that æther is matter conformable to all the laws which govern other forms of matter. Dr. Larmor, after referring to numerous experimental investigations in regard to the most varied optical phenomena, whether of ray paths or of refraction, dispersion, interference, diffraction, rotation of plane of polarization, all of which failed to indicate that the æther was subject to other than the ordinary laws governing matter, says:

* "The most obvious conclusion from this consensus of evidence taken by itself would be the view that the earth's motion carries the æther completely along with it, and that all the relatively optical and other phenomena are therefore just the same as they would be with both the earth and the æther at rest. Such a view is also very temptingly suggested by the absolutely negative result, up to the second order, of the earth's motion on the Michelson interference experiment. If we could assume that the earth's motion produces flow, differentially irrotational according to Sir George Stoke's criterion, in the surrounding æther but such that in all regions near the earth's surface, up to the greatest distance to which we can explore, the æther is practically carried along with the

* Æther and Matter, p. 12.

earth the requirements both of astronomical observation and of the mass of negative optical results would be fully satisfied."

As early as 1802, Dr. Young, who discovered the law of interference of rays of light, said, "All material bodies have an attraction for the ætherial medium, by means of which it is accumulated within their substance, and for a small distance around them, in a state of greater density, but not greater elasticity."

Faraday believed that æther is gravitative. Writing in Experimental Researches, he says, "The view now stated of the constitution of matter, would seem to involve the conclusion that matter fills all space, or at least all space to which gravitation extends, including the sun and its system. For gravitation is a property of matter, dependable on a certain force, and it is this force which constitutes matter."

In adition to the results of different experiments, all of which justify the conclusion that æther is gravitative, it will be shown later that the earth is a great magnet and that the æther surrounding the earth constitutes its magnetic field, and by electromagnetic action is bound to and rotates with the earth.

Chapter IV

The Atomicity of Matter

The generally accepted hypothesis of matter at the present time is that known as "Dalton's Atomic Theory," the term being adopted in honor of John Dalton, the originator of the theory.

Mr. Dalton seems to have first given his attention to chemistry about the year 1796, and within a few years had discovered a law which led him to conceive a necessity for the atomic constitution of the various forms of matter. In a paper "On the proportion of the Several Gases or Elastic Fluids Constituting the Atmosphere," read on the 29th of October in the year 1802, he says: "The elements of oxygen may combine with a certain portion of nitric gas, or with twice that portion, but with no intermediate quantity. In the former case nitric acid is the result, and in the latter nitrous acid."

It appears that the first germs of a connected atomic theory were formed in Dalton's mind by the observation of the separate existence of aqueous vapors in the atmosphere which rendered it necessary to infer that they were constituted of independent atoms. In a paper *On the Absorption of Gases by Water* which he wrote in 1803, he says: "A particle of gas pressing on the surface of the water is analogous to a single shot pressing

on a square pile of them," and a few years later he wrote, "Whatever therefore, may be the shape or figure of the solid atom abstractedly, when surrounded by such an atmosphere (of heat) it must be globular, but as all the globules in any small given volume are subject to the same pressure, they must be equal in bulk, and will, therefore, be arranged in horizontal strata like a pile of shot." He tells us also that it was at this time that he "was gradually led to those primary laws which seem to obtain in regard to heat and to chemical combination."

From the days when the atomic theory was propounded by Dalton to account for the elements uniting, chemically, in definite proportions, until the present, the idea has grown and developed until it is now regarded as a well established theory. The atomic theory presupposes that there is a limit to the divisibility of matter.

J. Clerk Maxwell's definition of an atom is "A body that cannot be cut in two." Dalton believed that an atom of hydrogen was the lightest atom in existence, but more recent researches indicate that even one of these infinitesimally small particles of gas may be divided into 700 parts, and that an atom of æther is only one one-thousandth the size of an atom of hydrogen. Lord Kelvin computed that 50,000,000 atoms of the gases could be put side by side in the space of one inch in length.

Chemists tell us that there are nearly eighty different bodies, from which it is impossible by any means now at our disposal to separate simpler substances. Each atom of these elements remains little changed through whatever chemical combinations it may undergo, and regardless also of whatever degree of heat and pressure it may be subjected to. Hydrogen and many other elements with which we are familiar exist in the sun and other celestial bodies and it is conjectured that their atoms in these bodies, and wherever they exist throughout the universe, are just the same as those belonging to our earth.

From the days of the Greeks down to the present time philosophers have set forth theories concerning the properties and shape of physical atoms. The cosmical theory propounded by Democritus * " Is of all the materialistic explanations of the universe put forth by the Greeks the one which has held the most prominent place in philosophical thought. All that exists is vacuum and atoms. The atoms are the ultimate material of all things, including spirit. They are uncaused, and have existed from eternity. They are invisible, but extended, heavy and impenetrable. They vary in shape ; though whether Democritus held that they vary also in density is debated. And, lastly, these atoms are in motion. This motion, like the atoms themselves, Democritus held to be eternal.

* Encyclopedia Britannica Vol. VII, p. 59.

According to some, he explained it as caused by the downward fall of the heavier atoms through the lighter, by which means a lateral whirling motion was produced; but whether this explanation was given by Democritus is extremely doubtful. Another principle also is said by some to have been used by Democritus to explain the concurrence of the atoms in certain ways, viz., that there is an intimate necessity by which similar atoms come together. However this may be, he did declare that by the motion of the atoms the world was produced with all that it contains."

Boscovich, an Italian mathematician and philosopher, taught that matter was atomic, as follows:

* "Each atom is an indivisible point, having position in space, capable of motion in a continuous path, and possessing a certain mass, whereby a certain amount of force is required to produce a given change of motion. Besides this the atom is endowed with potential force, that is to say, that any two atoms attract or repel each other with a force depending on their distance apart."

Lucretius, a Greek philosopher, tells us that an atom is a small hard body.

A more recent atomic conception is that of the Vortex Atom, first mathematically calculated by Helmholtz, and afterwards given its physical characteristics by Lord Kelvin. The vortex ring theoretically requires, for its formation, a perfect

* Encyclopedia Britannica, Vol. III, p. 37.

fluid. J. Clerk Maxwell ascribes to it the following as essentials to its constitution: it is a material substance; its motion is changeless; its mass is invariable; the form of a given portion of it may change but its volume always remains the same. He asserts that the perfect fluid is not molecular. He does not know "whether a substance having such properties actually exists, but from the mathematical theory remarkable results have been produced, some of which have been in a rough way illustrated by the use of imperfect fluids such as air and water."

Summing up the results of the equations and experiments, J. C. Maxwell says: * We have thus arrived at the following remarkable theorems relating to a finite vortex tube in an infinite fluid:— (1) It returns into itself, forming a closed ring. We may therefore describe it as a vortex ring. (2) It always consists of the same portion of the fluid. Hence its volume is invariable. (3) Its strength always remains the same. Hence the velocity of rotation at any section varies inversely as the areas of that section, and that of any segment varies directly as the length of that segment. (4) No part of the fluid which is not originally in a state of rotational motion can ever enter into that state, and no part of the fluid whose motion is rotational can ever cease to move rotationally. (5) No vortex tube can ever

* Encyclopedia Britannica, Vol. III, p. 45.

pass through any other vortex tube, or through any of its own convolutions. Hence, if two vortex tubes are linked together, they can never be separated, and if a single vortex tube is knotted on itself, it can never become untied. (6) The motion at any instant of every part of the fluid, including the vortex rings themselves, may be accurately represented by conceiving an electric current to occupy the place of each vortex ring, the strength of the current being proportional to that of the ring. The magnetic force at any point of space will then represent in direction and magnitude the velocity of the fluid at the corresponding point of the fluid. . . The conditions which must be satisfied by an atom are—permanence in magnitude, capability of internal motion or vibration, and a sufficient amount of possible characteristics to account for the difference between atoms of different kinds. . . When the vortex atom is once set in motion, all its properties are absolutely fixed and determined by the laws of motion of the primitive fluid, which are fully expressed in the fundamental equations. The disciple of Lucretius may cut and carve his solid atoms in the hope of getting them to combine into worlds; the follower of Boscovich may imagine new laws of force to meet the requirements of each new phenomenon; but he who dares to plant his

by Helmholz and Thomson (Lord Kelvin) has no such resources. His primitive fluid has no other properties than inertia, invariable density, and perfect mobility, and the method by which the motion of this fluid is to be traced is pure mathematical analysis. The difficulties of this method are enormous, but the glory of surmounting them would be unique."

It will already have been observed. from the sixth of J. C. Maxwell's theorems, that the energy of the theoretical mathematical vortex ring is synonymous with the action of electricity.

It is evident also that the perfect fluid of which he reasons could not be any substance of even so near an approach to gross matter as the æther whose waves produce the phenomenon of light. Thus it is seen that the trend of scientific thought endeavors to account for the atomicity of matter and also for motion in matter by means of electrical and magnetic action in the æther. Sir William Thomson accordingly tried to apply his vortex atom theory to the æther, but "he was unable to arrive at a satisfactory conclusion as to æther being composed of vortex atoms." The theory, however, is that atoms of electricity (electrons) form the substratum of which all matter is composed, and that each vortex atom is composed of a number

of these electrons. It is surmised also that these vortex rings, two, three, four or more, unite to form the denser matter. In the *Adams Prize Essay* of 1883, Thomson says:

"Thus an atom of one element may combine with another atom of the same kind, to form a molecule of that substance consisting of two atoms. Again, three of these atoms may combine, and form a system consisting of three primary elements, but the chance of their doing so is small compared with the chance of two pairing; so that the number of systems of this kind will be small compared with the number of systems consisting only of two atoms. We might have systems of four atoms, but the number would be small compared with the number of systems that consist of three atoms."

Sir Oliver Lodge also supports the theory that matter is composed of electrons. In his *Modern Views of Electricity* he says: "It is a fascinating guess that the electrons constitute the fundamental substratum of which all matter is composed. That a grouping of say seven hundred electrons, three hundred and fifty positive and three hundred and fifty negative, interlaced or interlocked in a state of violent motion so as to produce a stable configuration under the influence of their centrifugal inertia and their electric forces, constitutes an atom of hydrogen. That sixteen

times as many, in another stable grouping, constitute an atom of oxygen. That some sixteen thousand of them go to form an atom of sodium; about one hundred thousand an atom of barium; and one hundred and sixty thousand an atom of radium."

That the consensus of scientific thought today centres around the idea that there is an atomic æther in which motion takes place, as the starting point for all physical energy, is still further emphasized by Dr. Larmor, who, in *Matter and Æther*, (p. 77), says: "The master key to a complete unravelling of the general dynamical and physical relations of matter lies in the fact that it is constituted as a discrete molecular aggregate existing in the æther."

I have quoted thus extensively from the writings of philosophers and scientists on the subject of the atomicity of matter, not because I think that any of the theories they advance are a complete solution of the construction of matter, nor because my views coincide fully with any of the theories advanced, but because I believe the theories of modern scholars on the physical constitution of matter are far in advance of ancient philosophies on the same subject. The present research is unquestionably advancing on correct lines, and it is my cherished hope, in the suceeding pages of this work, to go a

step farther in the direction of a completer knowledge of the constitution of matter than has hitherto been attained. We shall build upon the foundation already laid by the labors of Maxwell, Thomson, and others. This basis assumes that matter is continuous throughout the material universe, and that all forms of matter are similarly constituted.

Chapter V

The Mechanical Constitution of Matter

Heat, light and electricity are all forms of motion in matter having their origin in one common source. But whilst scientists unite in admitting the relation existing between these three divisions of physical energy and their single source, they have not been able to determine the nature of that source in a perfectly satisfactory manner. The atomicity, sphericity, and elasticity of matter are generally accepted, for without these, ætherial and atmospheric waves and their attendant phenomena cannot be accounted for. The problem involves the question of the physical constitution of matter, and also the phenomenon of gravitation which is yet but little understood.

The vortex rings of Sir. W. Thomson, are the nearest approach to a workable theory of the physical constitution of matter which has yet been made, but that theory still leaves much unexplained that we should like to know. The vortex ring as Sir W. Thomson has left it is too incomplete and theoretical to become a solid basis for the building of worlds. He has conceived it as a hollow ring whilst there is a preponderating amount of evidence indicating that matter is composed of spheres more or less

solid. The rings also leave us in doubt as to whether, in the composition of matter, there is a positive and a negative atom, or electron, or whether there is but one kind of electron.

It is our purpose in this chapter to endeavor to satisfactorily answer some of these most difficult problems. The subjects treated will be dealt with from the standpoint of electricity, and the reasoning advanced will be based upon known phenomena, progressing from the simple to the more complex, each step always pointing the way easily to the next. Thus a system for the mechanical constitution of matter can be built up so lucidly that any one who cares to study the facts in their mutual bearing upon the system can readily grasp the principles elucidated.

Let a current of electricity be passed through a wire and the effect observed. The wire may be found, if taken in the hand, to be warm, or even hot, because the heat produced in different parts of the circuit is always proportional to the work being done. But an electric current produces another effect, which, if not quite so apparent as the heating effect, is of no less importance. Of this phenomenon (Fig 1), Prof. Sewell says: * "If we take a sheet of cardboard and make a hole in its centre, threading our conductor through it so that it stands perpendicular to the cardboard for a short distance

* Elements of Practical Engineering, p. 55

above and below it (the cardboard standing horizontally on two blocks of wood) and then sprinkle fine iron filings through a sifter evenly but sparingly all over the cardboard, we find that the filings set themselves in no definite order when no current is flowing but when we send a fairly strong current through the conductor, and, while it flows gently tap the cardboard so as to allow the filings freedom to move, we find them arranging themselves very definitely into circles around the conductor. If we increase the strength of the current, we notice on top of the cardboard that the filings have a tendency to be drawn closer to the conductor while evidence of the circular arrangement of the filings can

Fig. 1

be detected at a greater distance than before."

Of the nature of the phenomenon Professor Sewell says: * "The conductor appears to be jacketed throughout its entire length by some specialized condition of the surrounding space. To make this clear, imagine a circuit of small steam pipes, starting from a boiler, and going through various intricate paths to the exhaust. When a current of steam is passed through it, the space surrounding the conductor (pipes) will be in a specialized condition (heated). We need not touch the pipes to know that a current of steam is passing through them, for if we place our hands near to any part of the conductor we can feel that the space there is different to what it was when no steam was passing through the pipes, and this special state of the surrounding space exists round every part of the steam carrying conductor, including the boiler, where in all probability the effect is very much greater. If we increase the current of steam through the pipes the effect is felt at a greater distance.

"In our electrical circuit we influence the space around the current carrying conductor, dynamo as well, not by heating it, but by magnetizing it, and we have already seen that it exerts this influence in a circular direction, and that it apparently fades away as we go farther from the conductor."

* Elements of Practical Engineering, p. 56.

By observation of the action of the iron filings about an electrified wire it becomes apparent that some kind of pressure, or stress, is set up in the atmosphere, or in the æther, or in both the atmosphere and the æther, by the passage of the current. This stress is called magnetism.

The discussions on æther in Chapter III have already shown us that æther is electromagnetic. Although not previously referred to by us, wireless telegraphy demonstrates beyond controversy the electromagnetic nature of æther, even if other testimony concerning it were insufficient. In the chapter on paramagnetic and diamagnetic bodies we shall see that the atmosphere also is magnetic, though in a much less degree than æther.

A theory is advanced by Professor Larmor that æther is composed of electrons. He says: * "When an electron is put into motion it sends out a stream of radiations which lasts as long as its velocity is being accelerated: when its velocity has become constant, there is no more radiant energy sent out from it, though the previous sheets of radiation will continue to travel on into the more distant stagnant æther, leaving behind them ready formed the steady magnetic field of the uniformly moving electron."

Both Maxwell and Larmor, as is evident from their own writings, attribute electrical phenomena,

* Elements of Electrical Engineering, p. 1.

including electric and magnetic fields of electrified and magnetized bodies, to a motion in the æther. We assume, then, that the stress created in the region of the wire by the passage of the electric current is a stress in the æther. It is in an examination of the nature of this stress that we shall hope to find a solution of the subject now under investigation, namely, the mechanical constitution of matter. Sewell, writing of pressure, says:

* "In hydraulic, pneumatic, or steam engineering, the indications of the pressure gauge are of the utmost importance to the engineer; in fact he is always considering and asking about the pressure, and does not trouble himself much about the water, air, or steam, for none of these would be of any use to him unless they existed under a certain head of pressure. It is simply the pressure under which they exist that gives to them their working power.

"In a similar way the electrical engineer is always concerned about the electrical pressure; he does not talk or think so much about the electricity, but the electrical pressure is always in his mind as being of the first importance."

On the following page Professor Sewell points out the engineers meaning of pressure, thus.

"We may exert a pressure and still have no resultant motion; as, for example, suppose a

* Æther and Matter, p. 229.

man applies a pressure (a moving force) at one end of a table, which would of itself be able to move the table along the floor, if now a boy pushes at the opposite end and in the opposite direction, it is certain that the table would not be moved at all, although there is now a greater pressure being applied to the table than in the original case. It will therefore be seen that the result obtained does not depend on the pressure, but on the difference of pressure, and in all cases where pressure is spoken of it is the difference of pressure that is meant."

A knowledge of the principle laid down by Sewell, that wherever work is performed it is done by applied force of sufficient strength to more than equal all resistance, whether it be in the form of gravitation, atmospheric pressure, or something else, is of the utmost importance. To make our meaning more clear the principle of electrical action may be illustrated by the action of water seeking its own level. When one part of a body of water is elevated more than another, to use a phrase generally applied to electricity, there is a difference of potential, because the strain being exerted on one portion is different from that on another portion. Therefore the water having the highest potential flows down to a lower plane. There is always a difference of potential between the

two poles of a battery when a current is being sent through the wires—the negative pole having a lower potential than the positive pole. If it were not so the electricity could not flow, any more than water can flow up hill. This relation of the positive and negative poles of a battery has been said to be similar to the relation of heat and cold. The heat from a warm body radiates from it in all directions and each line of radiation must find its way to a body, no matter how small, which is colder than itself. Thus heat always moves from a body having more heat energy—a higher heat potential—to a body having less heat energy—a lower heat potential. In like manner a positive charge of electricity must invariably end on a body negatively electrified. Sewell says of electricity: * "No current could possibly flow unless there was a difference of electrical pressure in the circuit, in the same way that no water could possibly flow through a water conductor unless there existed a difference of pressure...All the so-called generators of electricity, dynamos, batteries, etc, are simply devices for producing and maintaining an electro-motive force." Having seen that an electric current flows through the wire conductor because of an excessive pressure at the positive end of the battery reference may now be made to a few

* Elements of Electrical Engineering p. 1.

familar phenomena for the purpose of demonstrating how liquids, as water, and fluids, as air, act when subjected to unequal pressures.

It seems to be a universal law that where a centre of energy passes through liquids and fluids, so as to form a line of energy proceeding from a point of higher pressure to one of lower, the matter at the point of the greatest extremes of pressure moves straight from the centre of high pressure to the centre of low pressure, whilst the matter somewhat removed from this centre of energy circles around it in a horizontal direction, namely, in a direction transverse to that in which the centre is moving. It is said to be impossible to have the water so quiet when flowing through a hole in the bottom of a large and shallow basin that it will not run into gyrations. These gyrations are a resultant energy arising from the perpendicular and horizontal motions above alluded to. In the eddies of streams and in the great whirl-pool of Niagara Falls the action is similar, the two forces ever being present. When standing above the terrible pool at Niagara I was intensely interested in seeing a long piece of timber float down the river until it reached the whirl-pool, at which point it was diverted to one side, and circled round and round, drawing nearer to the vortex with each revolution, until when, reach-

ing the centre, it was violently thrown upon end and thrust downward with awful force.

In the case of whirlwinds, cyclones and tornadoes, forms of energy like those of the whirl-pool exist. An examination of these shows that in the centre of each there is a comparatively small area of air moving violently upward whilst outside of this there is a large area of atmosphere moving at right angles, going around the centre in a horizontal direction

Now, the conditions created in the æther by the battery and the conductor are similar to those which exist in the whirl-pool and the cyclone. The battery, or dynamo, creates two extremes of pressure; these extremes are connected by the wire conductor, a substance which offers less resistance to the passage of ætherial energy than air, and which consequently acts like a hole in the bottom of a vessel containing water through which the liquid escapes, or like the heated area of air through which the cold air rushes up from below and produces cyclonic action. This being so the force of the electric current in the conductor and the magnetic field surrounding it, as represented in Fig. 1, and the laws governing electricity and magnetism become intelligible.

The electromagnetic energy always gyrates to the right. This is borne out by much evidence,

an example of which we produce in the following three diagrams. Each represents a cardboard with a series of pocket compass needles arranged in a circle around an electrified wire.

Figure 2 shows the compass needles all pointing northward when no current is passing through the wire. When a current is sent through the conducting wire downwards the needles arrange themselves as in figure 3. That is, the north poles turn to the right—clockwise—whilst the south poles turn to the left.

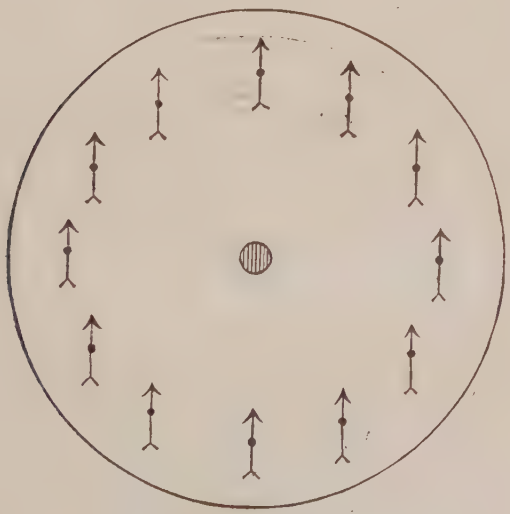

Fig. 2

Of the reverse action of the compasses shown in figure 4 Professor Sewell says: * "Not only is the space round the conductor magnetized, but it is magnetized in a certain definite direction. If we reverse the position of the wires joined to the dynamo or battery terminals we find that the compass needles all point in exactly opposite directions to what they did previously. We therefore know that some difference is made by the way we join our conductors to the dynamo; evidently by reversing the position of the wires on the dynamo terminals we have reversed the

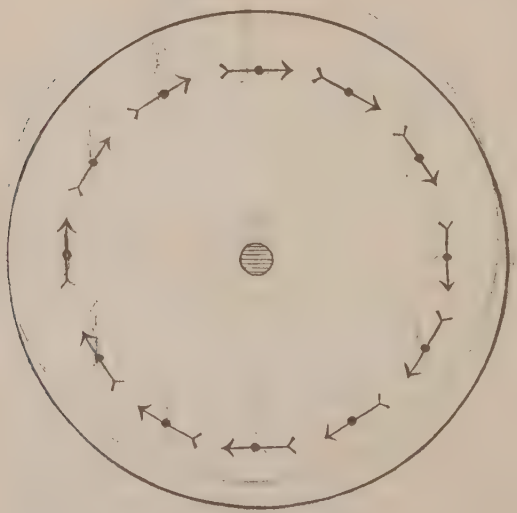

Fig. 3

* Elements of Eletrical Engineering, pp. 57, 58.

direction of the magnetized space or 'field,' as it is called, round the conductor." This action of the needles conclusively shows that the magnetizing force in the space around the conductor moves transversely around the electric current, agreeing with the theory previously advanced.

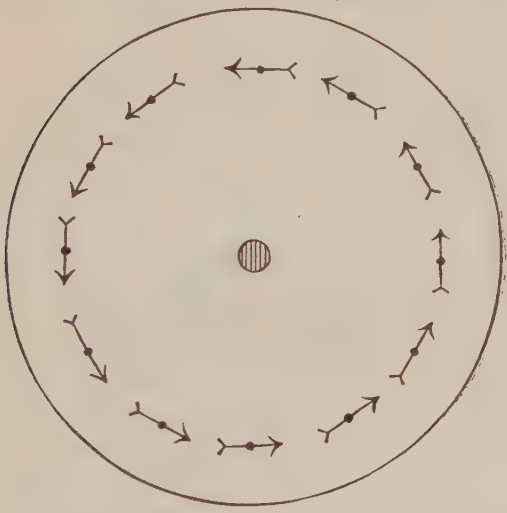

Fig. 4

The lines of energy which have just been described and illustrated by the circles of iron filings seen in Fig. 1, represent the magnetic lines of force which are present in every magnetized body, and furnish us the key to an understanding of the magnet and its wonderful power.

If instead of passing an electrified wire once through the horizontal cardboard as shown in figure 1, we bend it into the shape of a horse shoe and pass the two ends through two holes in the cardboard a few inches apart, and scatter iron filings on the board the effect produced is as shown in Fig. 5.

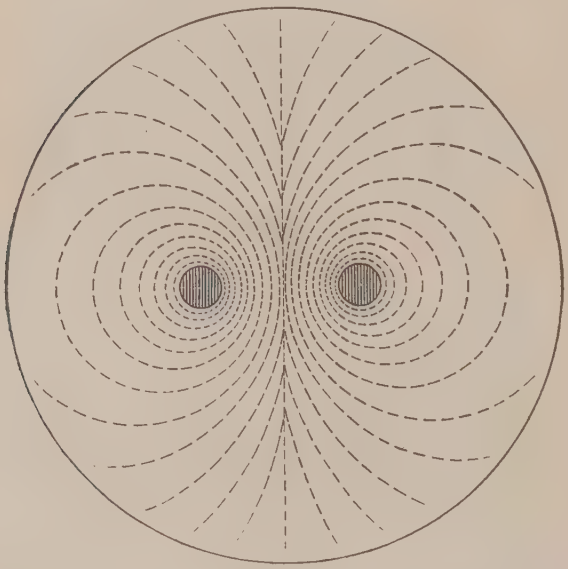

Fig. 5

In one wire the current is flowing out from the dynamo while in the other it is returning to it. The current in the two ends of the wire is therefore flowing in opposite directions. Now

that the conductor is sharply curved the magnetic lines of force come into contact between the two wires; consequently the lines of force are crowded together, the effect being that they become straightened and in the centre between the conductors they move straight out into space and away from the magetic field surrounding each conductor.

When an electrified wire is coiled around upon itself, it is evident from the above that the magnetic field round all parts of the current's circular conductor will form a ring, acting in some respects like the smoke-vortex ring. As the current flows through the conductor, moving from you, the magnetic energy in the vicinity of the wire moves around it clock-wise. Therefore the magnetic energy is coming into the ring on the right side and passing out on the left side, from whence it is carried around to the right side again to be drawn through the ring as before. This process agrees with the motion of the atmosphere in the vortex-ring, and the motion continues so long as the current flows through the conductor, but stops immediately when the current ceases to flow.

A study of magnetic action as shown in Fig. 5 makes it apparent that as there is a transverse magnetic field round all parts of the conductor which is itself formed into a circle, and that as

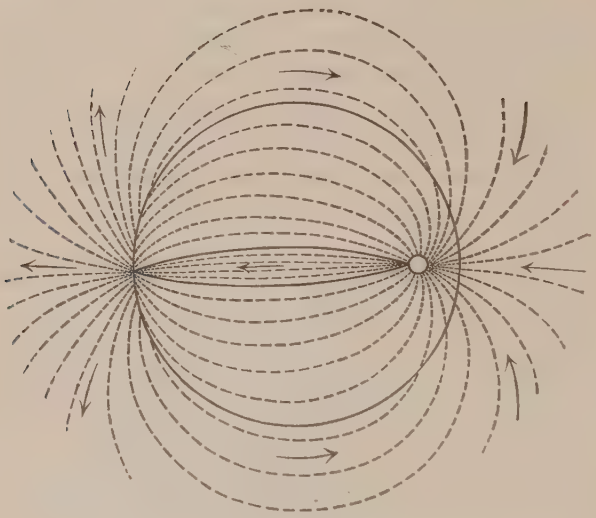

Fig. 6

in the interior of the ring the magnetic lines of force are crowded together and made to extend through the centre of the ring in straight lines, right and left, there is formed a magnetic globe, having an axis, the two ends of which are two magnetic poles, one the positive and the other the negative. We have here then an artificial magnet whose power is exactly like that of the loadstone. It should be borne in mind that while Fig. 5 represents the magnetic lines of force as extending out with equal energy right and left, the repellent energy of the two poles

is not alike in all respects, because one pole absorbs the magnetic lines of force while the other pole expels them, the reasons for which have been already assigned to the spiral magnetic strain surrounding the conductor. It is common, therefore, to speak of one pole as having repellent power and of the other as having attractive power, or of the poles as being positive and negative.

The magnetic sphere as far as it has now been constructed appears as represented in figure 6. The arrows in it show the directions in which the magnetic lines of force run. Let us consider the figure as representing the earth. Therefore it is in the sun's magnetic field. The lines which encircle it enter at the north pole and after passing through the earth and out at the south pole circle round on all sides of the earth and reenter at the north pole. These lines which complete the circle in unbroken continuity belong exclusively to the earth's magnetic field. But there are other lines near the centre, more or less curved, which do not complete their entire circle. Some of these lines nearest the centre of the earth are almost straight. Such lines belong rather to the sun's magnetic field, passing in at the negative pole and out at the positive pole. Thus it is seen that the earth's magnetism is induced by the sun's

magnetic lines of force passing through it. If the earth's magnetic field were sufficiently strengthened many of the lines which do not now connect around the sphere would complete their circles and their two ends respectively would be joined together, but in such case the magnetic field of the earth would be greatly enlarged and many new lines from the sun's field would pass through the earth, entering from outside the earth's field at the negative pole, and passing out into space from the positive pole. Therefore the general appearance of every magnet and its field, when excited to action, is similar to that represented in Fig. 6.

We saw in the electric current and also in the electromagnetic field of the conductor that the energy flows from a higher to a lower potential and that there is a constant tendency for the whole system to run down to one potential, or one level, and the motion to cease. This same law passes into the whole magnetic field when the conductor is coiled back upon itself and it becomes in mechanical constitution just like a natural magnet. In the electromagnet the source of energy at the dynamo must be constant or the magnet ceases to act. In the artificial magnet, as the compass, and also in the loadstone, the natural magnet, magnetic energy must be supplied by the

magnet being placed in the magnetic field of some other magnet, else there will be no magnetic action.

As a further evidence that the electromagnet constructed by coiling a wire conductor back upon itself is a true magnet, possessing all the powers of a natural magnet, there is the fact that it not only has the two poles of a magnet which attract and repel like the loadstone, but it also, like that, is able to magnetize other bodies by induction and to produce permanent magnets.

In the mechanical formation of an electromagnet I think we have a demonstration of the forces governing the formation of every atom, molecule, satellite, planet, and sun, in the whole universe. As a further step in demonstrating the truth of this we shall continue the study of the magnet in the next chapter.

Chapter VI

Magnetism

The word magnetism is of Greek origin, derived from *wayvñs*, a name applied to an iron ore discovered near the town of Magnesia, in Lydia, and which possessed an attractive power for iron. "It is now applied to all the phenomena kindred to that which first drew attention to the magnetic iron ore, viz., a selective attraction for iron."

The Greeks and Romans were aware that the loadstone, or magnetic ore, attracted iron and they probably knew also that it endued iron with which it came in contact with its own peculiar power. Their knowledge of the nature and scope of the magnetic influence was, however, very imperfect, and consequently much that they lacked in definite knowledge they supplied by their imaginations. The first real progress made in the science of magnetism had its rise in connection with the discovery or use of the mariner's compass in Europe. The Chinese claim the honor of having invented the compass, but some Europeans have called this in question. Klaproth, in a work published in French, at Paris, shortly before his death, says that the earliest reference to the use of the compass is found in Chinese history during

the reign of Ho-ang-ti, 2634 B C. It is said also that the power of the loadstone to communicate polarity to iron is for the first time explicitly mentioned in a Chinese dictionary written 121 A.D., where the loadstone is defined as a "stone with which an attraction can be given to the needle."

Referring to the compass in Europe Professor Maxwell says: * "The first accounts of the compass in Europe go back to the 12th century, and, although the instrument described is very rough, it is not spoken of as a new invention. In its earliest form it seems to have consisted simply of an iron needle which was touched with the loadstone and placed upon a pivot, or floated on water, so that it could turn more or less freely. It was found that such a needle came to rest in a position pointing approximately north and south (some accounts say east and west, in which case there must have been a cross piece on the needle to indicate what was probably the important direction for the mariner)." The early compasses were made of iron (steel not being used till much later) and their crudeness, together with their inaccuracy and want of a card, must have made them difficult to use.

The compass has had an important bearing upon the science of magnetism. Its discovery has led to five scientific deductions of much import-

* Encyclopedia Britannica, Vol. XV, p. 219.

ance: First, that the loadstone can transmit to iron with which it is brought in contact a property like its own; second, that a loadstone or magnet if suspended freely will turn so that a certain direction in it assumes a fixed position relative to the geographical meridian; third, that the magnet is molecular; fourth, that its poles follow the magnetic meridian, that is, the compass "dips"; fifth, that every action of a magnet is the result of an influence of some other magnetic body.

1. We have seen that the wire conductor of an electric current, the loadstone, and the artificial steel magnet all attract iron. Many experiments similar to that shown in Fig. 1, have been made and all with similar results. Place a bar magnet in iron filings and it presents an appearance as represented in Fig. 7. The phenomenon presented is that of the filings being attracted by the magnet. The scientist tells us that the filings are magnetized by induction. That his hypothesis is correct is proven by the fact that iron and steel subjected to strong magnetizing force, especially when frequently repeated, become permanently magnetized so that they are likewise able to magnetize other bodies. Such bodies also are magnetized by induction. Bodies permanently magnetized by induction become artificial magnets. The most perfect of these is

the mariner's compass. Professor Chrystal, after commenting upon a case of temporary magnetism by induction says: * "It is obvious, therefore, that the principle of 'induction,' along with the idea of 'retaining power' or 'coercive force,' furnishes us with the key to the explanation of the communication of permanent magnetism, whether by means of natural magnets or of artificial magnets, or of the electric current."

2. Professor Chrystal further says: "A loadstone or magnet if suspended freely will turn so that a certain direction in it assumes a fixed position relative to the geographical meridian, a certain part of the magnet turning always towards the north, and the part opposite towards the south. These opposite parts of the magnet are called its 'poles'". It has been ascertained that it is always the same end of any given magnet (when uninfluenced by another magnet) that points toward the north pole, hence this part is called the north pole of the magnet, while the opposite end is called the south pole.

3. Distinct from the question as to the cause of the action of one magnet upon another there arises the question of where the magnetic force lies. If we take up our magnet and plunge it into iron filings we shall find that the filings adhere almost entirely to the ends, the points designated the north and south pole respectively. Then if

* Encyclopedia Britannica Vol. XV, p. 227.

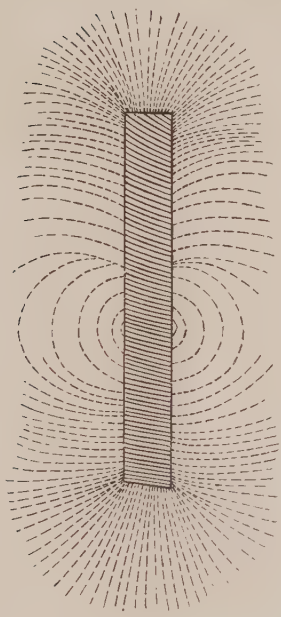

Fig. 7.

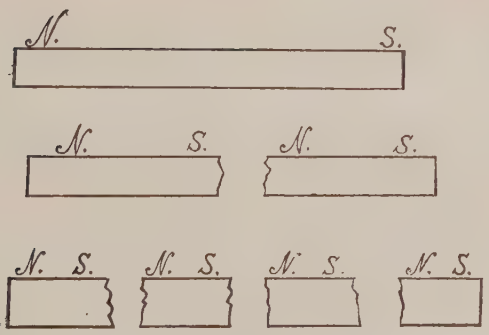

Fig. 8.

the magnet be broken in two, each half of it will be found to be a magnet, "the axes of the two halves being in much the same direction as that of the original magnet, and their poles in corresponding positions." If each of these two magnets be again broken in the middle each will likewise become a perfect magnet whose axis and poles will assume positions as in the original magnet, as shown in Fig. 8. Thus if a magnet be broken into any number of pieces, no matter how small, it will usually be found that each part of it is magnetic, the direction of the axes of the several parts bearing a recognizable relation to that of the whole. We are therefore led to the conclusion that the magnetic quality of a magnet is related to its molecular structure and not to its mass as a whole; that is, the molecules of a magnetic body are all miniature magnets.

4. The poles of the compass follow the magnetic lines of force. An examination of figures 5 and 6, Chapter V, will make it clear that on the equator of any sphere the magnetic lines of force run parallel with the surface of the sphere, but that at or near the geographical poles the lines of force are perpendicular to the surface of the sphere. The compass needle, besides pointing north and south also takes up a position in which it is parallel with the magnetic lines of force. This fact seems to have been first discovered by George

Hartmann, vicar of the church of St. Sebaldus at Nuremberg (1489-1564). In a letter to Duke Albrecht of Prussia, he says:

"Besides I find this also in the magnet, that it not only turns from the north and deflects to the east about 9° more or less, as I have reported, but it points downwards. This may be proved as follows: I make a needle, a finger long, which stands horizontally on a pointed pivot, so that it nowhere inclines toward the earth, but stands horizontal on both sides. But as soon as I stroke one of the ends (with the loadstone), it matters not which end it be, then the needle no longer stands horizontal, but points downwards some 9° more or less. The reason why this happens I was not able to indicate to his Royal Majesty."

Robert Norman, a skillful navigator, in 1576 independently discovered the dip. "He was in the habit of making compass needles, and carefully balancing them so as to play horizontally on their pivots before magnetization. He found that, after they were magnetized, they constantly dipped with the north end downwards, so that a counterpoise had to be added to bring them back to the horizon. This led him to construct a special instrument, the prototype of the modern dipping needle, to show this new phenomenon. With this instrument he made the first accurate measurement of the dip, and found it to be 71° 50′ at London."

The dip of the needle is dependent upon two facts in magnetism—that every magnetic body has polarity and that like poles repel and unlike poles attract each other.

We have become familar with the fact that the lines of force pass through the magnetic centre of each magnet and extend in curved lines all around it, forming a magnetic field which is spherical in shape (Figs. 5 and 6), the energy passing in at one pole and out at the other. This action and the cause of it were explained in Chapter V. And, now that the magnetic molecularity of the magnet has been satisfactorily demonstrated we are prepared to understand that the iron filings which adhere to the poles of the magnet, by what is called attraction, do so because each one has polarity and is, while in contact with the magnet, itself a miniature magnet by induction. At the positive pole of the magnet the negative pole of each filing adheres to the magnet, while at the negative pole the positive poles of the filings adhere to it. The filings are therefore arranged with reference to their polarity the same as the compass needles shown in figure 6, which represent the lines of force to be going in at the north pole and out at the south pole.

It is evident from the above that when two or more magnets are acting upon one another, or

are being acted upon by any magnetic force, they arrange themselves in a systematic order with positive and negative poles in proximity ; it is also manifest that if the positive and negative poles of two or more magnets are somewhat separated by intervening space and at the same time are exercising magnetic energy over one another, they must do so by means of the intervening æther. It has already been shown that the æther is magnetic ; so when magnetic action is induced its atoms are bound together, north pole and south pole, just as is exemplified in magnets of large dimensions.

When substances capable of magnetization, such as iron, are promiscuously arranged as to their particles as is presented by iron filings indiscriminately cast upon a cardboard, there is no apparent attraction among their parts. It is not until an electric current has been sent through them, or a magnet thrust upon them, that they arrange themselves according to polarity and exercise magnetic force. Therefore, it is surmised that the molecules of every magnet, each of which has been shown to be a miniature magnet, are systematically arranged, north and south poles in contact, and that because of this arrangement they are capable of exercising magnetic force when acted upon by another magnet. Furthermore, it is supposed that if the atoms of a magnet

were disarranged so that north poles did not join to south poles the magnetic power would be lost thereby. This conclusion has been borne out by a number of experiments. One of these is the phenomenon presented by breaking a magnet into a number of fragments and experimenting with its parts. Each fragment is a magnet having polarity, as previously shown, and a magnetic field like that exhibited by the whole magnet. If the several pieces are put together systematically, pole to pole, as represented above, they again become a single magnet, having two poles and lines of force as before. But if instead of being arranged with opposite poles in contact the different parts are promiscuously joined in a kaleidoscopic manner the magnet has no polarity and no magnetic field of account, iron filings in its vicinity remaining for the most part unaffected by it. Another experiment which lends credence to this view is that in many instances an iron magnet will lose its magnetic properties after being heated. It is thought that the intense heat has disarranged its molecules and thus destroyed its magnetism.

The question now arises why the rubbing of iron and steel with the loadstone, or with an artificial magnet, imparts to it magnetic properties. What has already been said leads to an answer. It is that before magnetization a great many of

the atoms of the metal were in promiscuous order but that the rubbing caused many of them to join pole to pole as is the case in the magnet. Writing of the polar arrangement of iron and steel under magnetic influence, Watson says :

* " If further we suppose that, in the case of steel, the molecular magnets having been once set in one direction they will remain in this direction, while in the case of soft iron, although under the influence of a magnetizing force the molecular magnets can be turned so that they lie in one direction, yet when the magnetizing force is removed, the molecular magnets do not remain in their regular arrangement, but again turn in all directions, the difference in the behavior of steel and iron can be at once accounted for."

A scientific reason for the dip is found in the electromagnetic constitution of matter. We have already traced the formation of the electromagnet from a simple electric current flowing over a wire between the two poles of a battery ; have learned the nature of its electric field and found in its magnetism all the phenomena of the natural magnet ; have seen also that when the conductor is coiled back upon itself it becomes a magnetic sphere with spherical lines of force passing around it and through its centre, and whose magnetism is supplied in the electricity flowing from the battery or dynamo. Further-

* A Text-Book of Physics, p. 591.

more we saw that the magnet, natural and artificial, has polarity, the opposite poles being linked together in every magnetic action; and that the magnetic fields of all magnets are composed of magnetic ætherial atoms or molecules, each bound to its fellow in the magnetic field; and these magnetic lines of force being curved around the outer circumference of the magnet and passed through its centre they are nowhere parallel with the surface of the magnet except at a point nearly over its equator, and the compass being a magnet like the ætherial atom, only of larger proportions, its poles must always be parallel with the magnetic lines of force of the earth, dipping, when north of the equator, to the north, and when south of the equator, to the south.

5. Every magnetic action of a magnet is produced by some other magnet, external to itself. Of this fact Professor Chrystal writes: * "When we reflect that in all our experience the properties of magnets, whether native, such as the loadstone, or artificial, such as the needles magnetized by rubbing with the loadstone, have proved alike, and that every purely magnetic action of a magnet has its source in some other magnetic body, we are naturally led to the conclusion that the reason why, at every point of the earth's surface the axis of the freely

* Encyclopedia Britannica, Vol. XV, p. 213.

suspended magnet assumes a definite position is simply that the earth itself is a great magnet, and that in observing the declination and dip we are simply exploring the magnetic field of the earth."

It is quite evident, from the philosophy of electromagnetism as confirmed by experience, that whilst some matter at least is electromagnetically constituted the source of magnetic action is not an internal energy, but is external to the magnet.

It has been the aim in this chapter to deal with magnetism only so far as seemed necessary to demonstrate the principles involved in magnetic action in their relation to the constitution of matter. We shall endeavor to show in the next chapter that ALL MATTER is electromagnetically constituted.

Chapter VII

Paramagnetic and Diamagnetic Bodies possess A Relative Magnetism

One of the phenomena of magnetism is attraction and repulsion, unlike poles attracting and like poles repelling one another. There is a repulsion also between so-called paramagnetic bodies and diamagnetic bodies when in a heterogeneous field. Enough has been said in previous chapters to lead to a definite knowledge of the cause of attraction and repulsion between the poles of magnetic bodies. The object of this chapter, therefore, is to show that molecules of matter are all similarly physically constituted and that paramagnetic and diamagnetic bodies are governed by the same electromagnetic laws; that is, all are, within certain limits, magnetic.

That a body which has not been magnetized may still be magnetic can be proven by the following experiment. Take a magnet and bring its north pole into proximity with the respective ends of a number of pieces of ordinary iron and it will be found that one end or the other of them will repel the magnet. Immediately the inquiry arises why this strange phenomenon? Experience teaches that the north pole of a magnet is repelled only by coming into contact with another magnetic north pole. Now this

same piece of iron which at first repelled the magnet, will, if the north pole of the magnet be persistently held near it for some time, by and by, cease to repel it and eventually attract it with considerable force. This phenomenon arises because the positive magnetism which the iron previously possessed has been overcome by a negative magnetism inductively imparted. This same experiment may be repeated with two known magnets of different strength and the result will be the same. The weaker magnet which at first repelled the stronger one will finally attract it. Concerning this fact Professor Chrystal writes: "The induced or temporary magnetism is superposed on the permanent magnetism, and, when the poles are near enough, the opposite magnetism induced by the pole attracts it more than the permanent like magnetism repels it; and this happens even with steel, whose susceptibility for magnetic induction is considerably less than that of iron."

Even diamagnetic bodies which in a heterogeneous field, repel the magnet have some magnetic permeability, which is equivalent to saying that they have a relatively weak magnetism. To say of one body that it is magnetic, and of another which is repelled by it that it is entirely devoid of magnetism is not good philosophy. It is like saying of one body it is hot and of

another it is cold when they feel so to the touch. For practical purposes such phraseology does very well, but for use in interpreting physical truth it is misleading because the common significance of the language referred to is that the cold body has no heat, whereas such is not the case, for no matter how cold it may feel to the senses it still retains some heat. Similarly one might suppose that light or sound consisted only of the sense of light or of sound, when these phenomena are accompanied by both longer and shorter waves of which the senses take no account.

Following the discovery of the loadstone many statements about its peculiar properties became current but it is now known that most of them were fabulous. Many experimenters later found indications of actions similar to that of the loadstone in brass and other metals, but most of them ascribe the phenomenon to the presence of an admixture of iron in those substances. It was afterwards ascertained, however, that a magnetic property was possessed by nickel and cobalt, and probably also by manganese and chronium.

* "Brugmans seems to have been the first to observe the repulsion by a magnet of a body not permanently magnetized. He found that a piece of bismuth floating upon mercury in a small paper boat was repelled by both poles of

* Encyclopedia Britannica, Vol. XV, p. 261.

a magnet. Lebaillif confirmed the observations of Brugmans, and found that antimony possessed a like property. Saigey who experimented on the same subject, concluded that all bodies when suspended in the air behaved like bismuth, unless they contained traces of iron.

"Notwithstanding these results and others which we pass over, the whole matter remained in obscurity till the repulsion of neutral bodies was discovered by Faraday in 1845. He speedily unravelled the laws of the phonomenon, showing how much depends on the nature of the body, and how much upon the nature of the magnetic field. His observations enabled him in fact to comprehend under a few general principles the action of all magnetic bodies whether of the nature of iron or of the nature of bismuth. The earlier observers had fallen into difficulties by neglecting the effects due to heterogeneity of field; these were pointed out for the first time by Faraday, and since then order reigns where there was formerly confusion."

Faraday's arrangement for testing the behavior of various bodies when subjected to magnetic action was to place them between two soft iron poles attached to the arms of a powerful electromagnet.

"The line joining these poles is called the *axial* direction of the field; directions perpendicular

to this line are called *equatorial*. The magnetic force varies along the axial line, being less in the middle than at the poles; and it decreases every where from the axial line outwards." By this means a heterogeneous field was created, and when any substance was suspended between the poles of the magnets, from a movable bar above, it would, when paramagnetic, move into the position of strong magnetism, but, when diamagnetic, it moved from the stronger field into the weaker.

* "The first substance with which Faraday experimented was a bar of the heavy glass with which he had discovered the rotation of the plane of polarization of light. It took up the equatorial position between the poles of the electromagnet as soon as the current was established. There was no distinction between its ends, or according to the direction of the line of force; the bar always took the shortest course to the equatorial position, and remained there in stable equilibrium. When placed in the axial position it was in unstable equilibrium, and on the slightest displacement either way it moved off in that direction to the equatorial position. A further action was observed when the bar was placed with its centre of mass out of the centre of the field; it was then repelled as a whole away from the nearest pole (no matter which).

* Encyclopedia Britannica, Vol., XV, p. 262.

On testing a small cube or sphere of the substance, no pointing tendency was observed, but the mass as a whole when it was placed unsymmetrically with respect to the poles tended to pass away from the poles toward the centre of the field, and from the axial line outwards.

"Faraday sums up the matter by saying that every element of the heavy glass tends to move from places of stronger to places of weaker resultant magnetic force. This is exactly the opposite of the law for bodies like iron. . . . . All bodies that follow the same law as heavy glass he calls diamagnetics, all that follow the opposite law, like iron, paramagnetics. . . .

"Faraday found the following substances to be diamagnetic; i.e., pieces of them tended to set their longest dimensions equatorially between pointed poles, and spheres and cubes of them tended to pass from places of stronger to places of weaker force: rock crystal, sulphate of lime, sulphate of baryta, sulphate of soda, sulphate of potash, sulphate of magnesia, alum, muriate of ammonia, chloride of lead, chloride of sodium, nitrate of potash, nitrate of lead, carbonate of soda, Iceland spar, acetate of lead, tartrate of potash and antimony, tartrate of potash and soda, tartaric acid, citric acid, water, alcohol, ether, nitric acid, sulphuric acid, muriatic acid, solutions of various alkaline and earthy salts, glass,

litharge, white arsenic, iodine, phosphorous, sulphur, resin, spermaceti, caffeine, cinchonia, margaric acid, wax from shellac, sealing-wax, olive oil, oil of turpentine, jet, caoutchouc, sugar, starch, gum arabic, wood, iron, mutton (dried), beef (dried), blood (dried or fresh), leather, apple, bread.

Faraday experimented with the metals also, and prepared a table showing their descending magnetic susceptibility. The paramagnetics in their order are iron, nickel, cobalt, manganese, chromium, cerium, titanium, palladium, platinum and osmium; the diamagnetics, bismuth, antimony, zinc, tin, cadmium, sodium, mercury, lead, silver, copper, gold, arsenic, uranium, rhodium, iridium and tungsten.

Adopting Faraday's terms for the expression of the two forms of magnetic effects upon different substances, it would appear from the long list given above, especially when we add to it a similar list of numerous gases which Faraday experimented with, that all matter is either paramagnetic or diamagnetic. It might be inferred from the results of Faraday's experiment with the heavy glass which showed it to be diamagnetic that it had no magnetism at all, but we shall show by the results of other experiments that its moving from a stronger area in the magnetic field to a position of weaker magnetism did not prove that

it was devoid of magnetism, but only that it was less magnetic than air.

Further evidence of the electromagnetic constitution of matter is found in another of Faraday's experiments. Concerning it Professor Chrystal says:

* " In all experiments with gases or fluid media, and indeed in every possible magnetic experiment more or less, it is important to notice that the resulting magnetic action is the difference between the action of the movable body and the action on the surrounding medium. This was first pointed out by Faraday. He prepared three solutions of ferrous sulphate. No. 1 contained 74 grains of the hydrated salt for every ounce of water; No. 2 was formed by diluting one volume of No. 1 with two volumes of water; No. 3 by diluting one volume of No. 1 with fifteen volumes of water. Three glasses of g^1, g^2, g^3, and tubes t^1, t^2, t^3, were filled with the respective solutions. The glasses were placed in succession between the pointed poles of the electromagnet, and the tubes tested with the following results :—

	In g.1	In g.2	In g.3
t1	O	+	++
t2	—	O	+
t3	— —	—	O

+ means axially; greater emphasis; O was indifferent.

++ the same with —pointed equatorially;

" We have here the experimental confirmation of the important theoretical conclusion that any body will behave paramagnetically or diamagnetic-

* Enc. Brit. Vol. XV, p. 263.

ally according as it is surrounded by a medium less or more magnetic than itself. In cases where the square of the susceptibility may be neglected, it is clear that the resultant action on any body is the difference between the action upon it and the portion of the medium which it displaces. This principle, which is the analogue of the Archimedean law for floating bodies, is of great use in the quantitative magnetic experiments."

Writing about paramagnetic and diamagnetic substances, Professor Watson says:* "Iron, nickel, and cobalt, the so-called magnetic metals, are materials in which the permeability is greater than unity, that is, greater than the permeability of air. In addition to t ese bodies there are others in which the permeability is only a little greater than that of air. All these substances are classed together as paramagnetic bodies. The great majority of substances, however, have permeabilities less than that of the air, and are said to be diamagnetic. The extent to which bodies exhibit diamagnetism is, however, very much smaller than the paramagnetism of iron, nickel, and cobalt. Thus bismuth, the most strongly diamagnetic body known, has a permeability of 0.9998, while the permeability of iron under certain conditions is as high as 2000."

* Text-Book on Physics, p. 722.

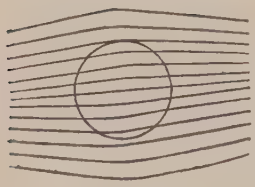

Fig. 10

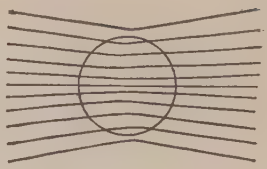

Fig. 9

The principle involved in the question of whether a body shall be designated paramagnetic or diamagnetic all depends, therefore, upon whether it is more, or less, magnetic than the atmosphere, and the phenomena manifest themselves in the relative conductivity of magnetic energy. The lines of force in the magnetic field, pass through a paramagnetic body more readily than they do through the air ; that is, more lines of force pass through it than would otherwise pass through the space which it occupies. This is well illustrated by Fig. 9 which shows the lines of force crowded together in the paramagnetic body. Exactly the opposite takes place in the case of a diamagnetic substance. There the lines of force, instead of being crowded together are forced apart so that fewer of them pass through the body than would pass through the space which it occupies. Fig. 10 shows how the lines of force are affected by a diamagnetic body.

The opposite action of paramagnetic and diamagnetic substances under the influence of

magnetic force is summed up by Professor Chrystal as follows: "It appears then that, by virtue of differential action, a body may behave paramagnetically or diamagnetically according as it is placed in a less or in a more permeable medium than itself." The paramagnetic body whose magnetic sensitiveness is so acute that it responds to the action of the lines of force and transmits their energy with more force than does the medium in which the body is situated creates a partial vacuum between itself and the magnet in whose field it is; therefore it tends to be drawn towards the magnet, while in the case of the diamagnetic body it obstructs the passage of the lines of force and causes a repulsion between itself and the magnet, therefore it recedes from the magnet. In the case of the first the ætherial waves in the body are more intense than those in the medium surrounding it, but in the second instance the waves are weaker than those in the surrounding medium. If the first should be placed in a medium of greater magnetic intensity than the strength of its own waves it would recede, or thereby become, for the time being, a diamagnetic body, and if the second, or diamagnetic body, were put in a field of less intensity than that represented by its own magnetic waves it would then move toward the magnet and thereby become a paramagnetic body. We are led to the

conclusion, therefore, that no substance is absolutely devoid of the power of being magnetized, and if it can be magnetized, even slightly, then it is not in the strict sense of the term, non-magnetic.

That the most strongly diamagnetic substances can be magnetized was fully proven by Plucker and Beer, and Faraday. Professor Chrystal in that part of his article on Magnetism where he treats of *Magnecrystallic Action*, says:* "In what precedes we supposed the inductively magnetized body, whether paramagnatic or diamagnetic, to be isotropic, and all experiments on its magnetic properties to be conducted in a heterogeneous field. In a uniform field such a body would be acted upon neither by force of translation nor by rotational couple. The case is otherwise if the body be magnetically aeolotropic. In this case, according to the mathematical theory, (1) the body ought to set in a uniform field so as to place its axis of greatest permeability (i.e., of greatest paramagnetic and of least diamagnetic susceptibility) parallel to the lines of force, and (2) in a heterogeneous field Faraday's translational force from places of less to places of greater resultant force in the case of paramagnetic, and from places of greater to places of less in the case of diamagnetic bodies, ought to be greatest when the axis of greatest susceptibility is parallel

* Encyclopedia Britannica Vol. XV, p. 254.

to the lines of force, least when the axis of least susceptibility is in the same position, and intermediate for other positions of the body. . . .

"The first observations of the magnecrystallic couple were made by Plucker, and elaborate investigations of the phenomenon were made by him in connection with Beer, in the course of which the magnetic properties of a large number of crystalline bodies were examined. Plucker also detected the magnecrystallic property in a rapidly cooled cylinder of glass. Shortly after Plucker's first results were published, Faraday discovered the magnecrystallic action of crystallized bismuth. At first, misled no doubt by the language in which Plucker stated the newly discovered facts, he did not recognize the identity of the two phenomena; but on further investigation he was able to class all the observations under a few simple laws, which in the mathematical form given to them by Thomson constitute the theory already given. To the observations of Plucker and Faraday Knoblauch and Tyndall added the important discovery that bodies in which the linear density in one direction is greater than in another, whether as a consequence of compression or of stratification artificial or natural, exhibit magnetic aeolotropy."

The sum of the evidence concerning the action of all bodies subjected to the influence of

magnetism is that there are none which do not respond more or less to it. Bismuth, the most strongly diamagnetic substance known shows magnecrystallic action. We rest here, therefore, in the assurance that all matter is electromagnetically constituted.

Chapter VIII

Every Atom is Cyclonic

Having already seen, in the phenomena presented by the magnet constructed by means of an electric current coiled upon itself, how the lines of force pass in at one pole and out at the other, we are prepared to take up, for fuller treatment, the subject of the forces which operate to bind atoms of matter and hold them inflexibly together in molecules, asteroids, satellites, planets, and suns. If we can clearly understand the formation of the ætherial atom and the molecule of grosser matter we shall have the key, at once, to the formation of all worlds and systems of suns and the basic principles which govern their motions. Let us go back to Chapter V, figures 2, 3, and 4, and see how the needle is influenced by an electric current. There as one stands facing the direction in which a current flows, the north pole of the compass turns round and points to the right and consequently the south pole turns to the left. Professor Chrystal has told us that the earth is a great magnet, because of which the compass needle points north and dips. Every one knows that the compass needle points towards the geographical north pole of the earth, but not every one is aware which of the

two magnetic poles of the earth is the real north pole, or what the so-called north pole actually means. Ferrel gives us a definition of what is meant by the positive and negative terminals of a battery, the former corresponding to the north pole and the latter to the south pole. He says: * "It follows that as a current of electricity always flows from a higher to a lower potential, just as water always flows from a higher to a lower level, we might state at once which of the two dynamo or battery terminals has the higher potential by simply noticing the direction in which the north pole of a compass needle is urged when placed in the field. This is known as the positive or + terminal, and the other the negative or — terminal."

A number of rules have been given for the determining of the direction a current of electricity is flowing by observing the direction of the compass needle when under magnetic influence. These rules are based on the assumption first made by Ampere and since adopted by other writers that the magnetism of the molecule, or of any magnetic body, is really the field of an electric current which circulates continually within it. Two of these rules as stated by Watson are as follows:

1. †"Imagine yourself swimming in the wire in which the current is flowing and facing the

* Elements of Electrical Engineering, p. 59.

† Text-Book on Physics, p. 667.

magnetic needle; then the north pole will be deflected towards your left hand, the south pole being deflected in the opposite direction (Ampere's rule).

2. "Place your right hand alongside the wire, with the fingers pointing in the direction in which the current is flowing, so that the palm of the hand is turned towards the magnet, then the outsretched thumb will point in the direction in which a north pole will be deflected."

One pole only of the compass invariably seeks the north pole of the earth. This is called the "north-seeking pole." This pole, when the compass is brought near an electromagnet, seeks to turn round and follow the magnetic lines of force to the magnetic pole having the lower potential. This demonstrates that the so-called north pole of the compass is a true north pole and that the geographical north pole of the earth is a south pole, and also that the electric currents at the surface of the earth flow from east to west. This is confirmed by Professor Watson who says: * "If we suppose that the earth's magnetic field is due to currents circulating round the earth, since the pole near the geographical north pole is what we call in magnetism a south pole, it follows that the currents must flow in the east to west direction, that is, in the same direction as the apparent motion of the sun."

* Text-Book on Physics, p. 722.

As previously shown æther has density, is gravitative and also electromagnetic. Furthermore we have demonstrated that all matter is relatively electromagnetic. Consequently we are writing on the hypothesis that whether matter is wholly composed of ætherial atoms or not each material molecule holds within itself a certain amount of æther and is surrounded by ætherial atoms bound to it as an electromagnetic field, the result of an electric current which circulates around it perpendicular to its axis. These molecules therefore contain a certain amount of electricity and the electromagnetic energy is in a constant state of flow in harmony with the laws governing electromagnetic energy, as already demonstrated.

A theory of the electromagnetic constitution of molecules with a flow of electricity around each perpendicular to its axis was first advanced by Ampere. This theory was afterwards worked out by Maxwell, who, without difficulty, deduced from it all the principal electrical and magnetic phenomena.

In electromagnetism the question of what is the nature of a current of electricity and of magnetic energy has been in dispute; that is, does the matter which is the medium of the energy move its position as water flows through a pipe or does it transmit energy by means of

waves only? My own belief is that while æther is so rapid in its action that it transmits light at an amazing velocity by undulations these undulations alone are insufficient to account for an electric flow. An electric current moves in a straight line from a point of higher potential to one of lower like a small stream of fluid, and with such rapidity that it causes a whirl in the surrounding medium. It is kinetic energy. In the entire realm of physical phenomena wherever kinetic energy is present it is the result of matter in motion. Electro-kinetic energy is a consequence of matter moving in a definite channel. Of this energy J. Clerk Maxwell says: "Since we can form no conception of electric current except as a kinetic phenomenon, its energy must be kinetic energy, that is to say, the energy which a moving body has in virtue of its motion."

According to the law of the electromagnetic constitution of molecules the ætherial magnetic energy all round the circle—360 degrees—is flowing from the positive pole, along the lines of force towards the magnetic south pole, the positive or north poles of the atoms facing in that direction. As they approach the magnetic south pole of their molecule or sphere the atoms dip 90° and finally turn completely round, their north poles keeping in front, and pass through

the centre of the sphere to their previous position at the positive pole.

Another important fact to be taken account of is that each atom is rotating on its axis which is parallel to the direction of the magnetic force, the two ends of each axis being the two magnetic poles. The discovery was made by Faraday after more than twenty years of experimentation with rays of polarized light in an effort to ascertain the effect of magnetism on light. J. Clerk Maxwell sums up the final result of Faraday's discovery as follows:

* "The discovery of the magnetic rotation of the plane of polarized light, though it did not lead to such important practical applications as some of Faraday's earlier discoveries, has been of the highest value to science, as furnishing complete dynamical evidence that wherever magnetic force exists there is matter, small portions of which are rotating about axes parallel to the direction of that force."

Building on Faraday's discovery of the axial rotation of the atoms of any magnetic sphere, as we follow the magnetic energy moving along the lines of force from molecule to molecule, of the earth for instance, from the south towards the north we may conclude also that the molecules composing the lines of force are at the same time revolving on their axes in a

* Enc. Brit. Vol. IX, p. 30.

fixed direction, being influenced by the direction in which the electric current and magnetic energy on the surface of the earth are flowing. When the ætherial magnets have moved to the magnetic south pole—the geographical north pole—and turned backwards along the lines of force passing through the axis of the earth southwards they are moving in an opposite direction from what they were doing when on the earth's surface. If by a fixed law these atoms and molecules are rotating on their axes in a fixed direction being impelled thereto by a fixed law as is generally supposed, then it is quite apparent that when in the centre of the earth, or any other sphere, the axial direction being reversed, they are rotating in the opposite direction from what they were when on the outer circumference of the sphere. Therefore in the interior of the earth there is a flow of electromagnetic energy opposed to that on the surface of the earth.

An analogous phenomenon is seen in the cyclone. All the phenomena of a cyclone agree perfectly with the phenomena known to us in the electromagnetic molecule. A comparsion of the two will, I think, establish the truth of this assertion. For the study of the cyclone we shall confine ourselves entirely to "A Popular Treatise on the Winds" by William Ferrel.

Professor Ferrel says:

"If the air over any portion of the earth's surface is warmer at all altitudes than that of the surrounding parts at the same levels, it is lighter, and tends to rise up above its original level, and flow out in all directions above. This decreases the pressure at the earth's surface over this area, but increases it a little in the surrounding parts; and thus there arises a gradient of pressure decreasing from the exterior to the interior below, which causes a flow of air in from all sides to supply the ascending current. There is thus a vertical circulation and interchange of air between the interior and exterior parts established, just as in the case of the general circulation of the atmosphere, except that now the motion is toward the central part below and from it above, while in the general circulation it is toward the polar central region above and from it below, the central region in this case being colder instead of warmer than the surrounding parts.

"It is not necessary, however, in order to have such a circulation, that all the strata of air from bottom to top shall be warmer in the interior than in the surrounding parts, but only that there shall be such a disturbance of the equality of temperature that the pressure of any part of the interior is less than that of the

exterior part, for where this is the case the air tends to rise up, and that of greater pressure at the same level to flow in and take its place, and thus the circulation is established. In general the velocity of the ascending current in the interior part is much greater, but over a smaller area, than that of the descending current in the exterior surrounding part over a much greater area, where it is simply a very gradual settling down, for since there is no definite limit, the tendency is for the air above to flow out to still greater distances, and thus to press down and bring in the air below from greater distances."

After dwelling at some length on the conditions which give rise to an unstable condition of the atmosphere, thereby causing cyclones, Professor Ferrel, writing of cyclonic gyrations says:

"If the earth had no rotation on its axis the air in the vertical circulation, in all such cases of local and temporary disturbances, would move in the lower strata directly toward the central part of the area of higher temperature and less pressure and out from it above, as already described, and there would be no gyratory motion around the centre. But in consequence of the earth's rotation, where a body moves in any direction on the earth's surface there is a force which deflects it to the right in the northern hemisphere, and the contrary in the

southern....The air therefore in the lower strata, in being forced in from all sides toward the centre, runs into a gyration around the centre, and this in the northern hemisphere is from right to left, or contrary to the motion of the hands of a watch....

"In the flowing away of the air above in all directions from the centre, it is deflected toward the right in the northern hemsphere by the same force as in running in toward the centre. The first effect is to counteract and overcome the gyratory velocity acquired by the air in being forced toward the centre, and after that it produces a gyratory motion in the contrary direction, that is, from left to right. Where the system of vertical circulation and gyratory motions becomes fully established, and the air which flows out from above is drawn in again toward the centre below, this gyratory motion from left to right has first to be overcome by the deflecting force before a gyratory motion from right to left begins to be generated. In connection, therefore, with every vertical system of circulation there is produced by the deflecting force of the earth's rotation two kinds of gyrations—the one, mostly in the interior part, from right to left in the northern hemisphere, and the other, mostly in the exterior part, in the contrary direction. The interior, and by far

the most violent part, is called a *cyclone*, and therefore the exterior and comparatively gentle part is properly called an *anti-cyclone*; and the two always go together. The gyrations of the former are properly called *cyclonic gyrations*, and those of the other *anti-cyclone gyrations*....

"From the centripetal motion of the air in the lower part of the atmosphere arises the deflecting force which gives rise to a cyclonic motion, and from the centrifugal motion in the upper strata, that which counteracts the cyclonic and tends to produce an anti-cyclonic gyration. Since there must be as much motion toward the central part below as away from it above, with a slight exception while the cyclone is forming or vanishing, in order to satisfy the condition of continuity, these deflecting forces are exactly equal and contrary to each other, and so, taken together, have no tendency to overcome the friction between the air and the earth's surface in the cyclonic and anti-cyclonic gyrations, but tend mostly, after the vertical and gyratory circulations are fully established, to overcome the friction between the strata of air having different gyratory velocities, and in part to change the gyratory moments. Before that, of course, especially at first, the forces are mostly spent in overcoming the inertia of the air in producing or destroying these moments....

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"The gyratory velocities at the earth's surface corresponding to the frictional resistances which are equal to the forces overcoming them, of course depend upon the nature of the surface and the law of resistance with regard to different velocities. For a homogeneous surface, however, whatever this law, it is evident that the velocities of the cyclonic gyrations must, upon the whole, be much greater than those of the anti-cyclonic, in order to have the sums of the moments of couple equal, since the former are much nearer the centre, unless the cyclonic gyrations cover a much larger area. But this is not the case, but rather the contrary; for the whole cyclonic area having no definite limit, the anti-cyclonic part is spread over a much larger area, and therefore the gyratory velocities are very small in comparison with those of the interior cyclonic part.

"The less the amount of frictional resistance at the earth's surface corresponding to any given gyratory velocity, the greater the gyratory velocities, so that at sea, with a smooth surface, the gyrations, with the same amount of energy spent, are greater than on land. And in the case of no such frictional resistances, as we have seen, they would become very great near the centre, the principle of the preservation of areas being satisfied in this case, and the whole deflecting

force in this case would act in overcoming the inertia of the air and producing gyratory momentum as it proceeds toward the centre in the cyclonic part, and in overcoming this momentum as the air flows back from the centre.

"Whatever the nature of the earth's surface and the gyratory velocities there, it has been shown that the difference between these velocities and those at any altitude above at the same distance from the centre are the same in any case, so that where the gyratory velocities at the earth's surface are greater for any reason, all those at any altitudes above are increased by the same amount."

"All the other conditions remaining the same, if we now suppose that there are gyratory velocities at the earth's surface, then all the velocities at all altitudes are changed by the same amount, taken algebraically when the gyrations change with change of altitude from positive to negative, that is, from cyclonic to anti-cyclonic or the reverse. Hence the pressure gradients change by the same amounts proportionally at all altitudes, and the pressure gradient at the earth's surface, depends simply upon the gyratory velocity at the surface, with the exception of the small gradient referred to above, sufficient to overcome the friction of the centripetal flow below."

The arrows, figure eleven, represent the opposite directions of the wind, the positive and the negative forces in a cyclone; the black circle in the middle is the place of highest pressure, the area outside it the gyratory anti-cyclonic region and that inside it the gyratory cyclonic zone.

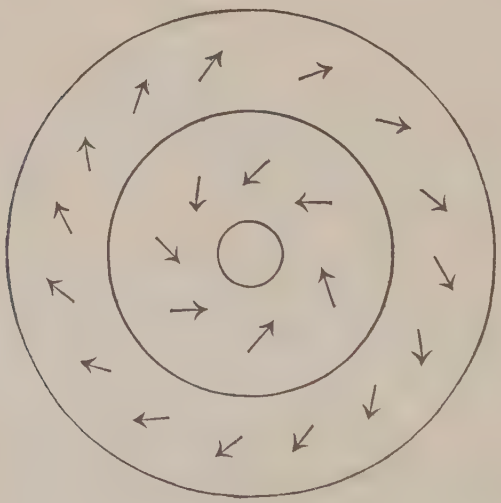


Fig. 11.

A comparison of the electromagnetic molecule with the dynamics of the cyclone reveals striking similarities, which show beyond question, an analogous physical constitution. The most significant phenomenon of the electromagnetic molecule is its polarity. The cyclone as a whole

is a single system of force and is as properly a molecule as is the electromagnetic molecule, which like the cyclone, is composed of myriads of smaller atoms. We should expect, therefore, the cyclone to have polarity. In this expectation we are not deceived. The cyclone molecule has polarity in all respects similar to that of the electromagnetic molecule. The lower end, where the atmosphere is drawn into the cyclonic region from the anti-cyclonic area beyond, corresponds with the magnetic south pole, and the upper end of the cyclonic molecule, where the atmosphere is thrown out in curved lines into the outer, or anti-cyclonic regions, agrees with the north pole of the magnetic molecule.

The cyclonic molecule also has its cyclonic field and its lines of force (pressure gradients) as truly as does the magnet. We have been shown by Professor Ferrel that the cyclone has its perpendicular and horizontal components of force; and that therefore the atmospheric lines of force in the lower half of the cyclone run from the perpendicular in the anti-cyclonic region, as the air descends, towards the cyclonic region nearer the centre, marking a gradient of curved lines which continue until they reach a point near the earth, from whence they ascend to the centre of the cyclone midway between the lower and upper poles. At this point they are crowded

into the smallest area and consequently the atmosphere here has the most rapid motion, but from the midway point the lines begin to diverge and as this divergence is gradual the path is still that of a curved line. This divergence continues until the lines reach the point in the anti-cyclonic region from whence they originated. Therefore the cyclone has lines of force as real, as those of the magnet, and agreeing in all important respects with its lines of force. Thus we see that one law governs the formation of the ætherial magnetic atom and the atmospheric cyclone, and we shall see also that it is the same energy by which these effects are produced. Professor Ferrel tells us that the cause of the cyclone is heat. The rays of the sun heat one part of the atmosphere while contiguous parts remain cool. Heated air is lighter than cold and its molecules are larger, and, there being a continuous strain in the atmosphere, the colder and smaller air molecules rush in to the space which, potentially, has become a semi-vacuum.

The cyclone including the anti-cyclonic area is a product of inequality of atmospheric pressure caused by the sun's rays. Sufficient evidence has been produced in these pages to show that in a similar manner many scientists now believe that somehow molecules are electro-dynamically formed through inequality of electro-dynamic

force in matter called æther. Indeed the theory has so much evidence in its favor that it can scarcely be doubted as a fact. Now, if it can be shown that all systems of matter are formed by the same laws which govern the ætherial molecule and the cyclonic molecule, we shall have established the principle that all matter is similarly constituted, being governed by one form or the other of the single energy known as heat, light and electricity. It will have been demonstrated also, that as every purely magnetic action of a magnet is the direct effect of the influence of some other magnet acting upon it, and as the formation of the cyclone and its motions, are the direct result of heat whose source is outside the cyclonic area, so the source of the kinetic and potential energy employed in the constitution of every particle of organized matter in the universe lies outside of each individual physical organism, and if outside of each individual organism it must also lie outside of all physical organisms combined.

Chapter IX

Perpetual Terrestrial Cyclones

The cyclonic system of the earth bears so close a relation to the physical constitution of matter in general as well as being very intimately connected with the physical forces prevailing on our terrestrial orb that I deem it expedient to devote one chapter to the cyclonic hemispheres into which the earth is divided. The earth's atmospheric circulation is cut in two, the dividing line pretty nearly following the geographical equator. The division, however, slightly varies according to the seasons, sometimes being north and at other times south of the equator.

It need scarcely be said that the principal cause of the motions of the atmosphere is the difference of temperature arising from the unequal distribution of the sun's heat over the surface of the earth. All forms of matter known to man are elastic. Most forms expand under the influence of heat and contract as the result of heat radiation. This is especially true of fluids. The atmosphere is not unlike other fluids in this respect, and so far as is known it has "no definite superior limit or surface." If the water in a resorvoir or in the sea were of the same density and at rest, its surface would everywhere correspond with the spheroidal surface of the earth and at every point

be perpendicular to the direction of the force of gravity. Thus the pressures in a horizontal direction on all sides would be exactly equal. The same is true also of the atmosphere surrounding the earth. From the nature of a fluid the pressure, when it is at rest, is equal in all directions at all points, but, when, from any cause, its surface is not level an unequal pressure is produced in the lower stratum at different places. This destroys the equal pressure which exists on all sides of any portion of a liquid at rest and causes an unstable condition. Therefore, either in the case of the water or of the atmosphere, that portion where greater pressure exists flows towards the place where there is less pressure. This state of motion continues until an equlibrium is established. The unequal distribution of heat on the surface of the earth being continuous, both the sea and the air are in a perpetual state of motion.

Every one has knowledge of the fact that the equatorial regions are hot and the polar latitudes cold, but since the motions of the air are almost entirely governed by this inequality of temperature it will be advantageous for us to study the subject a little more minutely. The sun's heat penetrates the earth in the tropics to a depth of only some five feet, whilst heat is absorbed by the ocean to a depth of forty-five or fifty feet. The land becomes very heated in lower latitudes

while in polar regions it remains comparatively cold, but the temperature on the oceans is more uniform over those parts of the surface of the globe because of the interchange of water by means of ocean currents. Thus there is constantly a difference of temperature in the atmosphere not only of different latitudes but also a difference of temperature in different parts of the same latitude. Prof. Ferrel says of this that, "While the temperatures at and near the equator are very nearly the same all the year round, in the higher latitudes of the northern hemisphere they vary very much in the different seasons of the year, and the temperature gradients between the equator and the pole are more than twice as great in midwinter as in midsummer. In the southern hemisphere, however, these annual variations are comparatively very small. This is because nearly all the land lies in the northern hemisphere and the southern hemisphere is mostly covered by the ocean, which equalizes somewhat the extreme temperatures of the seasons."

Continuing, Professor Ferrel writes: "Since aqueous vapor under the same pressure is lighter than air, its density being to that of air as 0.622 to 1, the unequal distribution of this vapor in the atmosphere also gives rise to small differences of normal pressure in different latitudes, or, in other words, to pressure gradients between the equa-

torial and polar regions, but these are small in comparison with those arising from difference of temperature."

Let us return now to the suggestion, previously advanced, of the atmosphere which surrounds the earth being in a state of rest, the pressure on any portion of it being equal in all directions, and the surface of each stratum of it being parallel to the spheroidal surface of the earth and perpendicular to the direction of the force of gravity. In such case all of the surfaces of the different strata of air would be parallel at every point between the equator and the pole, but if the atmosphere at any point were elevated or depressed by changes of temperature or other forces the surfaces of the different strata would no longer be parallel. It is known that there is a difference of temperature at the poles and the equator of about 45° C. The effect of increase of temperature being to expand the air the ratio of increase of volume is 1/273 part for each degree of rise at the temperature of melting ice. As the temperature of the equator is just about 45° C. warmer than at the poles the height of the air at the equator is therefore raised by 45/273, or 1/6 part of its entire depth. This being so the surfaces of the different strata of air are no longer parallel to the spheroidal surface of the earth, nor with one another, because at the equator, on account of expansion, each stratum of

air in the ascending scale is raised higher than the preceding one. The motion produced in the atmosphere by its elevation at the equator and in contiguous regions while remaining unchanged at the poles is described by Professor Ferrel as follows :—

" If this increase of the temperature of the equatorial over that of the polar regions were made instantaneously, the first effect of the expansion would be to cause gradients down which the air of the upper strata would tend to flow from the equator toward the poles. . . . At the earth's surface, however, there would be no tendency in the air to flow either from or toward the equator, since the mere upward expansion would not affect the pressure at the earth's surface, and thus give rise to a pressure gradient acting in either direction."

The gradual flowing of the air from the elevated strata of the warmer equatorial regions to the poles tends to produce a heavier pressure at the poles and to decrease the pressure a little at the equator. This effect extends to the lower stratum of atmosphere at the surface of the earth and causes a flow of air in that region from the poles towards the equator. Professor Ferrel, speaking of the motions of the atmosphere under these conconditions, says :—

" The neutral plane where there is no pressure

gradient, and consequently no motion in either direction, is now raised from the earth's surface up to such an altitude that the counter-flows between the equator and the pole, *from* the equator above and *toward* it below, satisfy the condition of continuity, and this altitude must be greater or less according to the relative amounts of friction in the upper and lower strata. . . . This must be above half the mass of the atmosphere. Since the upper part of the atmosphere has no definite limit but becomes more and more rare and extends to a very high but unknown altitude, the isobaric surfaces of the upper very rare part of the atmosphere have very steep gradients, which increase in proportion to the altitude above the neutral plane. But the force with which a given volume of air tends to slide down these gradients or press toward the pole is as the density, and this, where the temperature remains the same, is as the pressure. While the gradients, therefore, increase with increase of altitude above the neutral plane in an arithmetical progression, the forces of the same gradient decrease with increase of this altitude in a geometrical progression, and so become small above, while, by the nature of the gases, the frictional resistances for equal relative velocities between the strata are the same for all densities, and so the same at all altitudes. Hence the relative velocities between the strata, in the case of no

rotation of the earth on its axis, would be very small at great altitudes, and the absolute velocities nearly the same at all high altitudes. . .

"On account of the narrowing of the spaces between the meridians on approaching the pole the vertical plane between the descending air in the higher latitudes and ascending air in the lower ones, as in the case of the oceanic circulation, cannot be half way from the equator to the pole, but must be about the parallel of 30°. In the case of no friction the motions would be continually accelerated as long as any difference of temperature between the equator and the pole remained, but of course a very rapid and increasing interchange would tend to diminish and finally to sensibly destroy this difference. In the case of friction the motions would be accelerated until the frictional resistances would be equal to the forces, after which a uniform horizontal oscillatory motion would be maintained, the relation between the gradients and the frictional resistances being such as to leave a small residual force to alternately accelerate and retard the motions of the oscillations."

What we have already said about the motions of the atmosphere applies particularly to it when not considering the motions of the air arising from the forces produced by the rotation of the earth on its axis. We must now consider those forces

and the effects which they produce on the general circulation of the atmosphere. William Ferrel, in 1859, in an article published in Runkle's *Mathematical Monthly* on "The Motions of Fluids and Solids on the Earth's Surface" was the first to demonstrate that "If a body moves in any direction upon the earth's surface, there is a deflecting force arising from the earth's rotation, which deflects it to the right in the northern hemisphere, but to the left in the southern hemisphere." This is due to the sphericity of the earth. As the earth rotates toward the east, all bodies on its surface have an eastward velocity, and consequently an eastward momentum, but it is evident that the eastward velocity and momentum of a body at the equator are much greater than of a similar body at a point near one of the poles. A body at the equator set in motion in either a northerly or southerly direction seeks to maintain its eastward velocity whilst moving north or south, and as the earth's meridians continually draw closer together as one advances toward the poles, the body moving towards either pole and at the same time keeping up its equatorial eastward velocity will, at each successive parallel, arrive at a point farther east than it was when on the preceding parallel. Also, it is apparent that the contrary would be true of a body which started at or near one of the poles and moved into latitudes where the surface of the earth

had a faster eastward velocity than it possessed when at the starting point.

The effect of the temperature gradient is to produce an interchanging atmospheric motion between the equatorial and polar regions; also, in connection with this interchanging motion, as shown above, there are east and west components of motion caused by the earth's rotation. These east and west components of motion cause gradients of atmospheric pressure and consequently differences of pressure between different parallels of latitude. Quoting again from *A Popular Treatise on the Winds*, we read: "While the atmosphere if it had in all latitudes the same temperature, has no relative east or west motion, but only the absolute motion of rotation in connection with that of the earth's surface, the centrifugal force of rotation is just sufficient to cause the same ellipticity in the isobaric surfaces which the earth's surface has, and so to keep these surfaces parallel with the earth's surface. But if the atmosphere has an absolute east component of motion at all altitudes greater or less than that of the earth's surface, or, in other words, has an east or west component of motion relative to the earth's surface, then the atmospheric pressure at the earth's surface is no longer the same on all parallels of latitude, and the isobaric surfaces are no longer

parallel with the earth's surface, but pressure gradients with reference to this surface are produced in which the pressure either increases or decreases in a direction from the pole toward the equator, according as this component is east or west."

Investigation has shown that in both hemispheres atmospheric pressure increases from the poles toward the equator to about the parallel of 30°, where the pressure reaches its maximum, but from this parallel on to the equator there is a gradual decrease of pressure. There is therefore a low pressure, an atmospheric depression, at the equator, and there is a still lower depression at the poles.

The experiments which have been made apply, of course, to the air near the earth's surface. For reasons which will later become apparent it is believed that in the upper regions also a depression at the poles exists but that in higher altitudes the greatest pressure is transferred from the parallels of 30° to the region of the equator.

It is said that the change of pressure, or pressure gradient, depends only on the east and west components of velocity at the earth's surface and entirely vanishes where they vanish. This may better be understood by bearing in mind that the atmosphere above tends to move toward the poles and at the same time flows eastward faster than the eastward velocity at the earth's surface, thus

giving the air a gyratory motion in a direction a little north of east in the northern hemisphere and a little south of east in the southern hemisphere. At the poles it reaches its most northern and southern limits, settles down towards the surface and starts back toward the equator, retaining still its easterly motion, but gradually retarded by the earth's rotary tendency to throw it westward, as previously explained. By the time it has arrived at the parallel of 30° to 35° in its descent towards the equator, its velocity has been reduced to that of the surface of the earth. As the effect of the earth's rotation is to cause a body moving from the pole towards the equator to drift westward, from the latitudes of about 30° on each side of the equator to within a few degrees of the equator the atmosphere moves slower, in an easterly direction, than the motion of the earth. This produces the phenomenon of westerly winds, known as the trade-winds. But at the equator there is a calm-belt at the surface where the air tends to move neither west nor east, therefore, when the westerly trade-winds from both sides of the equator press against this calm-belt of only a few miles in width the intense heat in those regions carries much of the air upwards, but one effect of the coming together of the atmosphere in equatorial latitudes is to cause a reactionary pressure extending from the equator towards the north and

the south, reaching the parallels of 30°, or, in other words, the point where the eastward motion of the atmosphere is equal to the eastward motion of the earth. Consequently here there is a maximum pressure, whilst a slight depression exists at the equator. The trade-wind belt does not extend very high into the upper regions, the westward motion of the winds being overcome by the preponderance of the forces which carry the air eastward. Therefore, the depression at the equator grows narrower as it ascends and the maximum pressure belts which exist all around the earth at the parallels of 30° draw nearer to the equator as the altitude increases until finally they unite over the equator. When this occurs the atmosphere in those altitudes over the entire globe has an easterly velocity faster than that of the rotation of the earth. Professor Ferrel verifies the eastward motion of the atmosphere as follows :

"The frictional resistances to the motions of the atmosphere, except near the earth's surface, are so small that a very little interchanging motion between the equatorial and polar regions is required to give force enough to overcome the resistance to the east component of motion, especially in the higher latitudes. . . . . In the higher altitudes, therefore, where the east components of velocity are great in comparison

with the velocity of the interchanging motion, the resultant direction must be very nearly from west to east, being a little north of east in high altitudes where the interchanging motion is toward the poles, and a little south of east in the lower strata where it is from the pole." Elsewhere he says: "With regard to the strong easterly currents of the upper strata of the atmosphere in nearly all latitudes, as deduced from theoretical considerations in the preceding pages, any one of ordinary observing habits could scarcely live a week upon the earth without discovering from the motions of the clouds, and especially the very high cirrus clouds, that the general tendency of the air above is easterly, even in the lower latitudes where in the lower strata, there is a west component of motion, and that the velocities above in the middle and higher latitudes are much greater than at and near the earth's surface."

Other meteorologists have written similarly to the above. Espy says: "I have found the true cirrus clouds to average scarcely one a year from any eastern direction; and when they do come from that direction, it is only when there is a storm of uncommon violence in the east."

That the direction of the wind in higher altitudes, almost universally, is eastward has been ascertained definitely, by long series of observations in different parts of the earth. These points

of observation include Toronto, Canada; different latitudes in the U. S. of America, the West Indies, Central America, South America, the Sandwich Islands, the Himalayas of Asia, etc.

One of the most successful means of observation is the ashes of active volcanoes. Some of these instances are narrated in *A Popular Treatise on the Winds*, by Ferrel, as follows:

"On the 1st of May, 1812, the island of Barbadoes was suddenly obscured by a shower of ashes from an eruptive volcano of St. Vincent, West Indies, more than a hundred miles to the westward. Although the motion of the air here in the lower strata has a western component, yet the ashes were carried up to altitudes where the principal component of motion is toward the east, and hence the ashes were drifted in that direction. Also on the 20th of Jan., 1835, the volcano of Cosequine, Central America, lying in the belt of the northeasterly trade-winds, sent forth great quantities of lava and ashes, and the latter were borne in a direction just contrary to that of the surface winds, and lodged on the island of Jamaica, 800 miles to the east-northeast. In this case, also, the ashes were carried up to altitudes where the prevailing direction of the current of air was a little north of east, the northern component arising from the general pole-

ward motion of the air at all latitudes in the upper strata of the atmosphere."

The eastward component of motion of the atmosphere in high altitudes is confirmed by Lyell also where he writes of volcanic action on the island of Sumbawa, about 200 miles east of Java, as follows:

"On the side of Java the ashes were carried to the distance of 300, and 271 miles towards Celebes, in sufficient quantities to darken the air. The floating cinders to the westward of Sumatra formed on the 12th of April a mass two feet thick and several miles in extent, through which ships with difficulty forced their way.

"The darkness occasioned in daytime by the ashes in Java was so profound, that nothing equal to it was ever witnessed in the darkest night. Although the volcanic dust when it fell was an impalpable powder, it was of considerable weight when compressed; a pint of it weighed twelve ounces and three-quarters. 'Some of the finest particles,' says Mr. Crawford, 'were transported to the islands of Amboyna and Banda, which last is about 800 miles east from the site of the volcano, although the southeast monsoon was then at its height.' They must have been projected, therefore, into the upper regions of the atmosphere, where a counter current prevailed."

In 1883, of the volcanic eruption at Krakatoa,

it is written : "The volcano was ejecting, with a great noise, masses of pumice, and molten stone, and volumes of steam and smoke, part of which was carried away westward by the monsoon wind, dropping all around close at hand its larger pieces, while a high rising cloud is especially recorded as driving away eastward, having evidently encountered a current in that direction in the upper air. Some of this dust-cloud was carried far to the eastward, for Mr. Forbes relates that on the morning of the 24th of May, when in the island of Timor, twelve hundred miles distant, he observed on the verandah of his hut, situated high in the hills behind Dilly, a sprinkling of small particles of grayish cinders, to which his attention was more particularly drawn later on, and the next day by their repeated falling on the page before him."

Not only does the atmosphere in the higher altitudes move eastward faster than does that of the lower altitudes, but the eastward velocity is increased in proportion to the altitude. Professor Ferrel says of this that, "The velocities of the east components increase with increase of elevation, so that at great altitudes they become very much greater than those at the earth's surface; while those of the west components decrease with increase of altitude up to a certain altitude, where they vanish and change signs and become east

velocities, now increasing with increase of altitude to the top of the atmosphere."

It is evident that in the vicinity of the 30th parallel in lower latitudes there can be no east or west component of motion, as there the surface atmosphere coming from a polar direction and having an eastward motion, changes sign and takes a westward motion. This region, therefore, has comparative calm and is called "the tropical calm belt." Also being the region of maximum atmospheric pressure, there is a tendency for the atmosphere contiguous to the surface of the earth to be pressed out towards the equator on one side and towards either pole, as the case may be, on the other. This gives rise to a surface current flowing from the parallel of 30°, towards the equator. These currents join in the trade-winds and add considerable strength to them. The currents on the polar side of the tropical calm belt, respectively flow towards the poles. The opinion has been advanced that these currents, in either hemisphere, do not reach farther than the 60th or 70th parallel of latitude. However that may be I have no positive proof, but it would more nearly harmonize with the necessity of the equalization of forces in the cyclonic system if the polar currents extended to the poles and on to the outer atmospheric surface through the pole, where, as has been shown, is the minium of

pressure. This view seems to be supported by the experience of Captain Peary on his voyage in search of the north pole, in 1905-6. From Chateau Bay, Quebec, Lieut. Peary sent a letter to the New York Herald describing in detail his adventure in the Arctic. He says that the return journey was more difficult and perilous than the journey north, the wind being intensely cold, and "a fine drift of snow drove like needles" in their faces. The time of year when this strong southerly wind was blowing near the north pole was between April 21st and September 16th.

From what precedes it will be observed, that in the system of the circulation of the atmosphere of the earth as set forth in these pages, and confirmed by meteorology, there exist two ponderous, continuous cyclones, each covering half of the surface of the earth. Like the cyclone of smaller dimensions each has its cyclonic and anti-cyclonic area, but unlike the cyclone which has its base upon land these have their bases at the poles, or, rather, in the space beyond the poles, the lower temperature there in comparison with the higher temperature in other latitudes causing the air to flow in towards the equator from the higher latitudes and thence up and out poleward again. Enough has been said to show, also, that these hemispherical cyclones have the gyrations which always attend cyclones. In fact, no cyclonic

conditions so perfect as those in these cyclones exist elsewhere.

It is maintained that the constitution of the cyclone and of the magnet are, in important respects, applications of the same laws. The laws which govern each are subject to some modifications to suit the different conditions of each, but the general principles remain true to both.

Whilst the earth's atmospheric envelope is one it is at the same time composed of two systems—a double system of cyclones. At first it may appear that there is nothing in the constitution of the magnet which corresponds with the double atmospheric system of the earth. We find no trace of it in the simple magnetic system of the electric conductor, but there is something resembling it in the magnet which is a more complex mechanism than the electric conductor. The magnetic system is one, the energy flowing through the magnet and around from the positive pole through the lines of force in the magnetic field to the magnetic field of the negative pole; but, notwithstanding this fact, the system seems to be divided in the centre, the iron filings which are more magnetic than air being attracted to each pole with great energy whilst less magnetic substances are forced away. This is quite similar to the interchange of air which occurs in the hemispherical cyclones. Also, in the centre of

the magnet there is a flow of electricity around it resembling the trade-winds of the double cyclonic system of the atmosphere.

We desire to call the special attention of the reader to this similarity of a compound system in the magnet's field and in the earth's atmosphere and the flow of a current of fluid around the equatorial surface of both the magnet and the earth; also to the peculiar phenomenon that whilst the air-currents—the trade-winds — flow westward around the earth's surface the direction of motion of the air in high altitudes is eastward. These points remembered will be a step towards an understanding of our electromagnetic sun system and of the mysterious law of gravitation operating in it.

Chapter X

Energy and Stress

Before entering upon the consideration of energy and stress a definition of each should be given. According to Professor Garnett "Energy may be defined as the power of doing work or of overcoming resistance."

Of stress it may be said that whenever the volume or form of a portion of matter is changed a strain is produced. "The system of forces which is said to produce a strain is called a stress."

In physics energy and stress are inseperably related as cause and effect. Wherever one is present the other manifests itself in one form or another. Electric energy having been sufficiently considered in previous chapters independently, we shall now enter upon an investigation of it in connection with heat, light and chemical affinity, for the purpose of more clearly ascertaining in what way these phenomena are forms of electromagnetic action.

Concerning the phenomenon of heat Sir W. Thomson says:* "From the dawn of science till the close of last century two rival hypotheses had been entertained regarding the nature of heat, each with more or less plausibility, but neither on any sure experimental basis:—one that heat con-

* Encyclopedia Britannica, Vol. XI, p. 557.

sisted of a subtle elastic fluid permeating the pores or interstices among the particles of matter, like water in a sponge; the other that it was an intestine commotion among the particles or molecules of matter In the year 1799 Davy, in his first published work entitled *An Essay on Heat, Light and Combinations of Light*, conclusively overthrew the former of these hypotheses, and gave good reason for accepting as true the latter, by his celebrated experiment of converting ice into water by rubbing two pieces of ice together, without communicating any heat from surrounding objects."

As has been already intimated one phenomenon of electromagnetism is a wave motion in the field of a magnet. The energy which produces waves is of two kinds. First, there is energy moving along the lines of force of the magnetic field which enters the magnet at the negative pole and leaves it at the positive pole. Each ætherial magnet occupying a position in the series which constitutes any one of the curved lines of the electromagnetic field is bound to its fellow on either side parallel with the line of force The attraction between each particle at these points where positive and negative poles meet draws the particles together in such a way that the tendency is to shorten the line. As this line of force through the poles and around the magnet forms an unbroken ring which

is in a strain at every point, all lines of force being similar in this respect, a stress is produced throughout the entire electromagnetic field. The passage of energy through an elastic substance subjected to such a strain produces waves in the medium.

In a previous chapter we saw that in the case of an artificial magnet an electric current flows around it and that the electromagnetic field of the magnet is really the electric field of the current. Thus it is theoretically concluded that currents of electricity are connected with all electromagnetic action. Therefore Ampere believed that the earth's magnetism is the result of electric currents flowing in and around the earth. This being so the earth and all other magnets are electrified bodies. Now, in the field of every electrified body there are electric lines of force perpendicular to the electromagnetic lines of force. Along these lines of force electricity flows, or is radiated out in all directions the same as are light and heat from hot bodies. Whenever a body of lower electric potential comes within the electric field of a more strongly electrified body some of the electric lines of force from the latter enter the former on the side nearest the inducing body as negative electricitiy. Every electric line of force leaving an electrified body must find a resting place on a

body of lower electric potential. It is therefore evident that in every electromagnetic field there is an electric radiating strain in addition to the stress along the electromagnetic lines of force and perpendicular to it. This electrical strain also produces waves. This is fully demonstrated by the wave motion of light which has been shown to exist, and which moves along these electric lines of force.

We may find it helpful in our study seeking a basis for physical unity to observe here that the energy of heat, light and electromagnetism decrease from the centre of disturbance outwards inversely as the square of the distance, and all the waves, whether of one or another of these three phenomena, are transverse and can be in similar manner reflected, refracted and polarized.

The medium of the transmission of either of the above forms of energy is æther. Enough has already been said about light and electricity to leave no doubt as to the medium of their transmission being æther, bnt we have now to see what evidence there is to show the nature of the medium of radiant heat. This can be done by placing a hot ball in a glass receiver and pumping out all the air, so that a vacuum is formed all around the ball. When the receiver is surrounded by matter colder than the ball in the vacuum heat is radiated through the vacuum, the walls of the

receiver and into the matter outside, which in consequence rises in temperature. Again, reverse the action by heating the matter outside the receiver and placing a cold ball inside in the centre of the vacuum. Then the ball gradually rises in temperature until it is the same as that of the matter outside of the receiver. A similar experiment with sound waves demonstrates that sound is transmitted only when air or some form of matter more gross that æther fills the receiver. No sound is heard through a vacuum from the vibrations of the ball when struck. Hence we know that something we call æther, doubtless the same substance as the medium of light and electrity, is the medium of radiant heat also.

The centres of all these forms of energy are nuclei of denser matter than that of which the magnetic fields are composed.

Electromagnetic action, as previously demonstrated, manifests itself in a medium surrounding a magnet or some magnetic body which serves as a nucleus for electromagnetic energy.

Light is an electromagnetic wave motion in a medium surrounding some illuminated body, the motions of whose molecules produce the illuminating rays.

The above is true of radiant heat also. Professor Watson says: * "There is conclusive evidence that radiant heat, after it leaves the

* A Text-Book on Physics, p. 291.

hot body, exists as a wave motion in some medium surrounding the body. Now, in order to set up waves in a medium, we must have a body which is itself in motion in the medium. Thus, since a hot body can set up such waves, we infer that it must be in a state of motion. Also, since the highest power microscope is quite unable to detect any motion in a hot body, we infer that this motion must be a motion of the molecule as a whole, or of the parts of a molecule, or both combined."

Whilst the nature of heat, light and electromagnetism is the same they each represent a difference of degree of that energy, each of which produces its own peculiar effect upon matter and upon our senses. The electromagnetic wave being very short and its action correspondingly rapid, the ætherial waves somehow unite with the wave motion of the molecules or particles of the magnet and pass through or over them with a minimum of molecular disturbance. Light and heat are phenomena of longer wave lengths than those of magnetism and affect the molecular arrangement more. Electromagnetic energy passes freely and instantaneously through the solid magnet from pole to pole, even though it be a body as large as a planet or a sun, but the waves of light and heat are not so transmitted, the energy

being reflected, or absorbed and emitted as heat of a different wave length. Melloni was the first to discover that most transparent substances when used as screens stop a much larger proportion of dark heat than they do of light. Moreover he proved that different bodies transmit through their substance different quantities of heat when exposed to a constant radiation, and also that the heat issuing from each different substance is of different quality.

Another phenomenon of heat is its weakening effect on magnetism. Of this Professor Chrystal says; * "That very high temperatures destroy both the magnetic susceptibility and the power of retaining magnetism altogether has been known since the infancy of magnetic science. Thus Gilbert found that a loadstone and a piece of iron equally lost their power of affecting the magnetic needle when heated very hot, and remarks that the magnetic property returns to the iron after it has cooled a little, but that the magnetic virtue of the loadstone is altogether destroyed."

Canton and Hallstrom's experiments showed that if a magnet be repeatedly heated and then allowed to cool to its initial temperature the magnetization lost at each heating is only partially recovered on cooling, but that if the process be repeated a sufficient number of times

* Encyclopedia Britannica, Vol. XV, pp. 271-2.

a stage is reached where all the magnetism lost in heating is regained by cooling. The evidence in the case all shows that heat weakens magnetic energy when applied to magnetic bodies.

Heat, in addition to weakening magnetic energy, has an almost universal power of causing matter to expand and throw off the heat energy in radiations. It has been usual to attribute the cause of the expansion of matter by heat to the centrifugal effects of the rotation of the molecules. This alone, however, seems to be insufficient to produce the observed phenomena connected with heat radiation. Under the influence of electromagnetism a body expands less than when subjected to heat, although heat waves and magnetic waves are of the same nature and of kindred origin. In both these forms of energy the molecules are supposed to turn on their axes, and as magnetism acts more rapidly than heat, if expansion be entirely due to the centrifugal force electromagnetism should cause more expansion than heat, but such not being the case some other cause than the centrifugal force must be sought for heat expansion and radiation.

For an understanding of the nature of the molecular disturbance attending heat we need only carefully to observe the conditions prevailing

in matter as cyclonically constituted. We previously demonstrated that the electromagnetic phenomena of any system is precisely the phenomena of a cyclone, the action whithin the magnet corresponding to the cyclonic area and the electromagnetic field corresponding to the anti-cyclonic area. In both the magnet and the cyclone there is an accelerated motion of matter which affects the entire system. In J. Clerk Maxwell's dynamical molecular vortex theory, after telling us that "the vortices are separated from each other by a single layer of round particles" he says: "They are perfectly free to roll between the vortices and so to change their place, provided they keep within one complete molecule of the substance; but in passing from one molecule to another they experience resistance and generate irregular motions which constitute heat. These particles play the part of electricity. Their motion of translation constitutes an electric current. Their rotation serves to transmit the motion of the vortices from one part of the field to another. The tangential pressure thus called into play constitutes electro-motive force; and the elastic yielding of the connecting particles constitutes electric displacement." Here Maxwell makes two important statements. First, that there is a translation of particles from molecule to

molecule in the electric current; and, second, that the irregular motions these particles experience in their translation constitute heat. If this theory has truth in it there is a translation of æther through the magnet when magnetic action takes place as well as of air through the cyclone.

We previously remarked that the long heat wave disturbs molecular action more than does the short magnetic wave. Its action is such that the electromagnetic field of any system is cut in two at the equator, making two heat or meteorological systems of one magnetic system; but there are several agreements between the magnetic system and the double meteorological system. There is an equatorial current flowing around within the system in either case—an electric current around the magnetic system and an air or other fluid current around the meteorological system. Take the terrestrial system as an index of all physical systems from an atom to a great sun system. It will later be shown that the same electromagnetic system as exists in our earth exists also in our solar orb, and also the same double meteorological system. Thus we conceive that the same constitutional laws govern all systems, allowing for certain modifications to suit local conditions. The magnetic system of the earth has one magnetic pole on each side of the earth not far

from the geographical pole, one being positive and the other negative. Consequently the magnetic energy flows round from the geographical south pole, through the magnetic field to the north pole. The meteorological system of the earth also has a cyclonic pole or base on each side of the earth near the geographical pole, but unlike the magnetic pole the cyclonic poles are both negative. They are the poles into which the atmosphere enters to be thrown up and out near the equator. Therefore the cyclonic energy due to heat flows from the equator polewards in the upper regions and from the poles towards the equator in the lower regions. If each molecular system is electromagnetically constituted it has a fluid or liquid field of varying densities around the more solid nucleus, and in this field or photosphere there is the double cyclonic system due to heat whose energy in considerable part is moving in opposition to the electromagnetic energy and disturbing the magnetic allignment of the molecules and their particles. Furthermore, as proven in the earth's meteorological system, secondary cyclones are numerous in certain parts of the hemispherical cyclones. The energy of the secondary cyclones is perpendicular to that of the terrestrial or primary cyclones (See Fig. 15), and also to the electromagnetic lines of force—that is, the

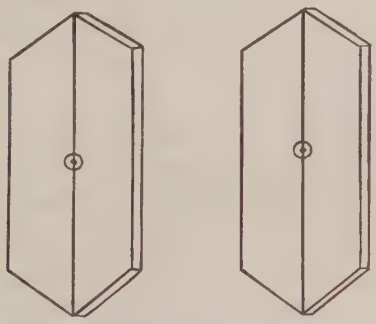
energy of the secondary cyclones moves parallel with the electric lines of force of the earth, and with the direction of radiant heat also. It seems very reasonable therefore to conclude that radiant heat consists of a displacement of ætherial particles which, when loosed from their environments within the molecules of denser matter escape radially in miniature cyclonic or thermo-electric energy, corresponding to the energy of secondary cyclones operating in a primary cyclone, and striking into other systems of matter set them into commotion. Such a hypothesis agrees with the kown facts of matter and accounts for the phenomena of the weakening of magnetic energy, expansion, and also when sufficient intensity has been reached for the melting of the molecular systems, and for light.

Therefore, heat may not only be described as "a form of motion in matter," but also more minutely as a "thermo-electric repulsion in matter" along the electric lines of force in opposition to electromagnetic attraction along the magnetic lines of force.

Light has been a very difficult subject for scientists to study experimentally but a few facts demonstrated by sepectroscopic analysis, interference, and polarization have led to a definite knowledge that light is propagated by

waves in the æther and that its energy is electromagnetic.

The interference of light has previously been sufficiently referred to for our present purpose, but the phenomena attaching to polarized light require a more minute investigation. For, when its nature as an electromagnetic energy is understood it becomes a strong proof in support of our conclusion that radiant heat is the escape of ætherial particles in cyclonic gyrations—an electromagnetic phenomenon.



b. Fig. 12. *a.*

The polarization of light may be performed with two slabs of the crystal of tourmaline cut parallel to the crystalographic axis. Two such plates of crystal are represented in figure 12, a and b. A shows a ray of light passing through the axis of the slab. Of the effect Professor Watson says:

* "Part of the light will pass through, and will, with most specimens of tourmaline be colored greenish owing to selective absorption within the crystal, otherwise to the eye the character of the light appears unaltered, and remains of the same intensity if the tourmaline plate is rotated. If the light which has passed through one tourmaline plate is allowed to fall on another, placed with its axis parallel to the first, the light will pass through the two; the only visible effect will be to slightly darken the greenish tint, the intensity being very slightly diminished by the second plate. If, however, the second plate is gradually rotated round an axis parallel to the light, so that the axes of the two crystals are inclined at a finite angle to one another, the intensity of the transmitted light will gradually diminish, till, when the axes are at right angles, none of the light which has passed through the first plate will pass through the second. Hence the light which has passed through a plate of tourmaline has acquired properties which it did not before possess, in that it can no longer pass through a second plate of that substance when this plate is turned so that its axis is perpendicular to the axis of the first plate."

In figure 12 a represents the first plate of tourmaline crystal, used for the polarization of

* A Text Book of Physics, p. 566.

light. The perpendicular line through the middle lengthwise is its axis and the dot in the centre the point where a ray of light is passed through it. This light, after passing through the crystal seems little changed from what it was before, except in color. Also, when the crystal is rotated on its axis no change in the light occurs, however, a marked feature of it is that if b, the second plate, be moved up near a as they now stand with their axes parallel the light passes freely through both plates. But if a remains stationary and b is turned around gradually, the light fades and when b has been turned one-fourth round, or until their axes are at right angles to each other, the light does not pass through the second plate at all.

Light waves are transverse to the path of the ray of light, but physicists, concerning it, are divided into two schools, one being led by Fresnel and the other by McCullah. The former concludes that the wave is up and down, parallel to the axis of the crystal, and the latter thinks that the wave is across the axis of the crystal; in other words one school thinks the wave is perpendicular to the ray and the other that it is horizontal to it, and neither school seems to know what relation it bears to the phenomenon of light. But Professor Maxwell strikes the right key, when he says, "The process may, however,

be an electromagnetic one, and as in this case the electric displacement and the magnetic disturbance are perpendicular to each other, either of these may be supposed to be in the plane of polarization."

Strong evidence proving that light is electromagnetic is found in the rotation of the plane of polarized light. Faraday was the first to discover that the plane of polarization of a beam of light when passed through a magnetic field in the direction of the lines of force rotates, owing to its passage through the magnetic field.

If a ray of plane polarized light is passed through quartz or any similar body the plane of polarization rotates as when the ray is passed

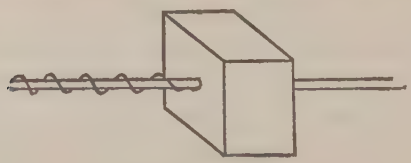


Fig. 13.

through the magnetic lines of force of a coiled electric current. In figure 13 Watson gives what he considers to be the action which takes place as the ray passes through the quartz. After the polarized light passes through the quartz it seems to rotate or twist to the right, that is, clockwise, as shown in the figure. It does this both when it has been passed through the lines

of force of a magnetic field and when it has passed through the quartz only. The action in both cases is precisely like that of the magnetic needle trying to go round the electric current.

The evidence establishing the rotation of the plane of polarized light cannot be questioned, but, there has been uncertainty as to what it is that rotates and how the rotation takes place. In other words, the uncertainty has been the result of the want of precise knowledge of the nature of light. Our knowledge of what light is may be aided by comparing the action of heat in colloids and other crystals of the cubic system with that of other systems of crystals which exhibit characteristics "analogous to those deduced from their double refraction, conformable with the optic axes of the crystal, and referable, as in the latter case to axes of elasticity, or unequal compression of the molecules.

Senarmont demontrates the difference in heat conductivity of the two forms of crystals, by an experiment which he describes as follows:

* "The fundamental fact is easily shown by taking two slices of rock-crystal, one cut transverse to the axis and one parallel to it. Through the centre of each plate a small hole is drilled for the reception of a bent wire, which by insertion into the hole sustains the plate. The other end of the wire is to be heated, and the rate of the

* Encyclopedia Britannica, Vol. XVI, p. 377.

conduction of the heat is rendered visible by the amount of this coating of beeswax, with which the plate has been previously coated, which is melted round the central hole. It will be seen that in the transverse slice the wax is melted in a circular form, while in the longitudinal slice the form is elliptical. The conduction is equal in all directions, as regards the transverse axes of the hexagonal prism, but more rapid in one direction in the longitudinal slice, and that direction is the line of its optic axis. In the case of quartz the two diameters of the ellipse are as 1000 to 1312.

Fig. 14.

"If the regular distribution of amorphous bodies be interfered with by unequal tension or compression, the regularity of their power of conducting heat is destroyed, and they also showed elliptical forms of melted wax; and the shorter axis of the ellipse is in the line of pressure or undue packing of the molecules. The heat thus does not travel so fast in this direction,—partly because it is spent in the heating up of the greater number of molecules. Hence we might conclude that along the main axis of the quartz a smaller number of molecules

are packed in an equal space than along the transverse."

The crystal of tourmaline used for the polarization of light was the same in formation as the rock crystal, which conducted heat from a wire passing through a hole in its centre in an elliptical form. The waves transmitted by heat, light, and electricity all being transverse to the direction of energy it is evident that the light waves, like those of heat, are thrown into an ellipse by passing through the tourmaline. The magnetic fields of the ætherial molecules, also, are probably thrown into ellipses, like the ray itself. It is now easy to understand the phenomenon presented by the passage of a ray of light unobstructed through two plates of polarized crystals when they are near together and their polar directions are parallel, but when one is turned perpendicular to the other the light is cut off, because the ellipses no longer coincide with each other.

Light, in a homogeneous medium, travels in a straight line and its waves are rectilinear, each wave, in a homogeneous medium, being in every part equi-distant from the centre of the ray. In a medium not homogeneous such as the tourmaline crystal the surfaces of the magnetic lines of force become elliptical. Light in its speed of propagation, its wave motion, the

direction of rotation of the plane of polarization clockwise,—except in the case of light passed through certain forms of crystals,—acts in the same manner as does electricity. We must conclude, therefore, that a ray of light is synonymous with a current of electricity with an electromagnetic field rotating around it. The electromagnetic nature of light, therefore, is fully established. All currents of electricity do not, however, produce the phenomenon of light, and the inquiry naturally arises why one electric current is transparent while another is not. The only reason known at present is that the phenomenon of light is a sensation just as sound is a sensation and that the eye is able to discern electrical sensations of certain wave-length only.

It is significant that light waves are always associated in the spectrum with electric and heat waves. Spectroscopic analysis shows that the waves of light are shorter than those of heat and longer than those of electricity; hence light lies between the other two. There is a relation between the three phenomena and it seems as if there is some special reason why light occupies the central position, as if it were the product, in some mysterious manner, of heat and electricity. This, I am inclined to think, may be the case.

The ancients understood the principle of producing sparks by striking the flint, and aboriginal races have long been familiar with the possibility of originating fire by friction between two pieces of wood. Again, who has not observed sparks fly from a horse's shoe when struck against a stone, and also, more frequently, flashes of light and balls of fire fall from the connecting arm of an electric car when jarring or knocking occurred? The striking of a match, a flash of lightning, the light due to combustion, all bear witness that light is in some manner caused by matter brought into violent contact with matter. The electric light also still further demonstrates this fact. It usually consists of a carbon film, a dielectric, so inserted that the current must flow through it, making it thus an obstruction to the free passage of electricity. As the ætherial particles trike into the carbon they clash with the irregular motions of the molecules of that substance; consequently heat is generated and radiated as light.

We have previously seen that each molecule of matter, being electromagnetically constituted, is enveloped in an ætherial electromagnetic field, and it seems that in combustion, the striking of flint, the electric light and kindred phenomena, molecular diamagnetic action, the effect of heat repulsion as opposed to magnetic attraction,

becomes so intense that the magnetic fields erupt, or even explode. Then some of the particles fly in all directions, giving rise to electric currents which radiate into space, and which are such a wave-length that when they fall upon the retina of the eye the optic nerve experiences undulations corresponding therewith, and the sensation of light is produced. Thus the phenomena of light all bear testimony to the correctness of our conclusions as to the cause of heat radiation, and the nature of the energy and stress attending heat, light and magnetism.

The chemical affinity of matter should now claim a share of our attention. Dr. Larmor has advanced the opinion that the electro-dynamic atom theory will be able to account for ordinary forces of cohesion. In this opinion the writer fully concurs. On this subject Professor Larmor writes:

* "It is to be observed that on the view here being developed, in which atoms of matter are constituted of aggregations of electrons, the only actions between atoms are what may be described as electric forces. The electric character of the forces of chemical affinity was an accepted part of the chemical views of Davy, Berzelius, and Faraday; and more recent discussions, while clearing away crude conceptions, have invariably tended to the strengthening of that hypothesis.

* Æther and Matter, pp. 165-6.

The mode in which the ordinary forces of cohesion could be included in such a view is still quite undeveloped. Difficulties of this kind have however not been felt to be fundamental in the vortex-atom illustration of the constitution of matter, which has exercised such fascination over high authorities on molecular physics; yet in the concrete realization of Maxwell's theory of the æther.....the atom of matter possesses all the chemical properties of a vortex-ring in a frictionless fluid, so that everything that can be done in the domain of vortex-ring illustration is implicitly attached to the present scheme."

With the well developed theory of the constitution of matter, as set forth in these pages, I think we may advance a step further and suggest a practical theory for the cohesion manifested in chemical phenomena. We should bear in mind that the molecules of oxygen, hydrogen, and other forms of matter are each and all to a greater or less degree magnetic, as proven in Chapter VII, although some are classed as diamagnetics. Therefore each of these atoms, although it may remain detached from other atoms, is a centre of electromagnetic force. It has, consequently, an electric field of smaller or larger dimensions and of more or less strength, but the sizes of different kinds of molecules are not the same and their electric

fields vary as to strength and area. It is, therefore, easy for some of the larger and stronger molecules to absorb others in their electro-magnetic fields when their wave motions have been brought into accord under the energy of heat and electricity. We have illustrations of a similar phenomenon in primary and secondary cyclones. A larger cyclone sometimes has several smaller ones in it. In reality the number of cyclones and sub-cyclones in one of the hemispherical cyclones of the earth is almost beyond calculation, they are so numerous. A similar phenomenon is seen in the solar system, which, as I shall hereafter show, is a tremendous electro-dynamic cyclone embracing many lesser ones.

Of the secondary cyclones Professor Ferrel says:

* "It often happens that the conditions of a smaller cyclone, or even several of them, are contained within the limits of a larger one. The isobars, which in a perfectly regular cyclone are circular, become very irregular. The contained cyclone may be such as to give a secondary minimum pressure, or it may simply produce derangement in the regularity of the isobars of the primary cyclone. Where the isobars become crowded, and consequently the barometric gradients steeper, the velocities are likewise greater;

* A Popular Treatise on the Winds, p. 315

for in such places the motions of the primary and secondary cyclones are somewhat in the same direction. Where, however, the isobars are farther apart, and the gradients consequently smaller, the velocities are also smaller, since

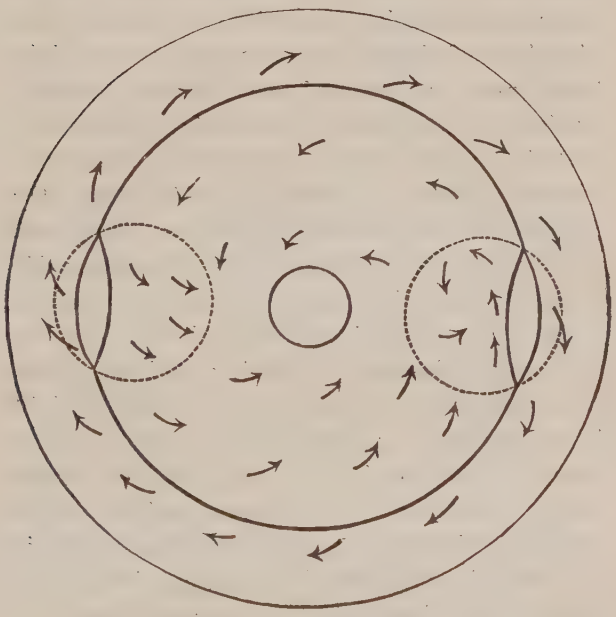


Fig. 15.

there the motions are nearly in contrary directions, and partially or quite neutralize each other." Writing of the effects of secondary cyclones contained in a primary, upon the isobars and

the directions of the wind Professor Ferrel says,

"In the one on the left the depression is not sufficient to give rise to a secondary minimum of pressure, but merely to cause considerable derangement of the isobars, crowding them together on the one side and widening them on the other, and changing somewhat the velocities and directions of the wind. The one on the right being more violent and the depression deeper, produces a secondary centre of low pressure, with the wind blowing around it, but with much greater velocity on the right side, where the directions of the currents of both the larger and smaller cyclone coincide, than on the other side where the cyclonic motion of the smaller cyclone is but little greater than that of the larger in the contrary direction. The ring of high barometer of the large cyclone is increased in height in an irregular manner by those of the smaller ones falling upon it. There are usually many smaller secondaries of this sort, which tend to distort the isobars, and to cause irregularities in the velocities and directions of the wind as the cyclone and its second areas pass over any place of observation."

Although the cause of cohesion, or chemical affinity, has not been definitely proven, the phenomenon of a primary cyclone embracing several smaller cyclones, and in a similar manner

the solar system containing its primary and several hundreds of planets, asteroids and satellites, strongly favor the hypothesis that electromagnetism and heat are the main causes of chemical affinity.

If, as we have supposed, electricity, magnetism, light, heat, and cohesion all can be accounted for by the electromagnetic theory of the constitution of matter there is only one physical phenomenon of similar nature remaining to be considered, namely, gravitation. It will be investigated in the next chapter, where a scientific reason will be advanced showing that it, also, is a phenomenon of electromagnetism and heat.

Chapter XI

Our Great Solar Magnet

Through the study of terrestrial electromagnetic phenomena we have learned much of the nature of electricity and magnetism, and of the inseperable relation of heat, light and magnetism as electric energy; also, not only that the loadstone and certain metals are magnetic but that all matter is relatively magnetic. We have come to understand also the very important fact that the earth is a large magnet continually exercising electromagnetic energy within itself and consequently in its environment over a vast ætherial area as its electromagnetic field. This at once suggests the inquiry whether the earth itself is not a secondary magnet in the field of a much greater magnetic system. Our minds almost instinctively turn to the sun as the source of all earthly physical phenomena, including electromagnetism.

There is a striking similarity between the way the sun produces daily changes in meteorological and magnetic phenomena. Owing to the sun's heat there is a daily fluctuation of temperature which reaches its minimum from 4 to 6 a.m. and its maximum from 2 to 4 p.m. There is also a more or less regular diurnal oscillation of atmospheric pressure due to the variations of temperature.

It is believed also that the sun is in some manner connected with certain daily and annual magnetic phenomena. The most common of these is the diurnal oscillations and fluctuations of declination of the magnetic needle. We have seen that the needle points approximately towards the geographical north pole, and that going north from the equator the north pole of the compass dips, this declination increasing until the magnetic pole is reached, where the needle stands perpendicular to the geographical meridian. But there is a diurnal fluctuation of declination, and an oscillation in an easterly and westerly direction. For example, the solar-diurnal variations of the needle at Kew, a station in middle latitude, northern hemisphere, for the whole year are as follows: At 10 a.m. the needle is normal, pointing due north. At 11 a.m. the north pole of the needle is pointing 2.68 minutes of an arc west of the magnetic north pole of the earth; at noon 5.13 west; at 1 p.m. 6.19 west; at 2 p.m. 5.81 west; from then on to 6 p.m. it slowly returns eastward and at the hour of 6 p.m. it has reached a point only 0.39 minutes of arc west of the magnetic meridian. A few minutes later it is again normal. At 7 p.m. it has moved to a point 9.22 east of the meridian. It now slowly moves farther and farther east until 8 a.m., when its position is 3.80 east. From here it

returns towards the meridian and at 10 a.m. is only 0.46 minutes of arc east of the meridian. Shortly after 10 a.m. it has reached the meridian, from whence it started, having made one complete vibration. Observation shows that the needle moves from its extreme eastern position, 3.80 east, where it is at 8 a.m., to its extreme western position, 6.19 west, where it arrives at 1 p.m., consuming only five hours, whilst in returning from its most distant western position to its farthest eastern position it requires the remaining nineteen hours of the whole twenty-four. It is evident from the fluctuations of the declination of the needle that there is a force affecting it other than the undisturbed magnetic field of the earth.

In the southern hemisphere the oscillations and declinations of the needle are similar to those of the northern hemisphere except being just the opposite; that is, when the needle in the northern hemisphere is inclining eastwards that in the southern is inclining in a similar degree towards the west.

We have just seen that, as proven by the oscillations of the needle, there are two secondary magnetic systems of the earth superimposed upon its primary magnetic system. These two systems compare nearly with the two meteorological systems, which, as shown in a previous chapter,

exist in the northern and southern hemispherical cyclones, with an equatorial calm belt between them. This calm belt, the dividing line between the two systems, is farthest north at the June solstice and farthest south in December. In the magnetic systems and the meteorological systems those of the northern half are opposed to those of the southern, and the two systems are in other respects so nearly in agreement that it strongly suggests one set of governing causes. This relation between the meteorological and magnetic systems has been recognized by several eminent writers, and the cause has been attributed to electrical and magnetic action of some sort.

As stated by Professor Balfour Stewart, the following theories have been advanced to account for magnetic diurnal variations: * "(1) It has been supposed that the sun acts directly as a magnet upon the magnetism of the earth. (2) It has been imagined that convection currents established by the sun's heating influence in the upper regions of the atmosphere are to be regarded as conductors moving across lines of magnetic force, and are thus the vehicle of electric currents which act upon the magnet. (3) Faraday, reasoning from his discovery that oxygen is paramagnetic and becomes weaker in its power when heated, and stronger when cooled, supposed that the sun by heating certain portions of the at-

* Encyclopedia Britannica, Vol. XVI, p. 181.

mosphere renders them less magnetic while others, not subjected to any heating influence are rendered more magnetic. The action is equivalent to a displacement by means of the sun of the magnetic matter of the earth, and involves a displacement of the magnetic lines of force. Here too the solar action is associated with the great mass of the atmosphere. (4) It has been supposed by Christie and by De la Rive that the heat of the sun produces in the atmosphere and in the earth thermo-electric currents which produce the daily magnetic variations. It is not easy to perceive how we could have thermo-electric currents in the upper regions of the atmosphere, but there is no obvious objection to such currents in the crust of the earth. Thus the first hypothesis has no reference to the atmosphere whatever; the second deals with upper atmosphere regions, the third with the great body of the atmosphere, while the fourth, as we have ventured to modify it, has reference to the crust of the earth."

Professor Stewart, after reviewing the theories of these scientists, concludes by saying, "We are thus driven by the method of exhaustions to look to the upper regions of the earth's atmosphere as the most probable seat of the solar influence in diurnal magnetic changes, and it need hardly be said that the only conceivable magnetic cause

capable of operating in such regions must be an electric current. Now we know from our study of the aurora that there are such currents in these regions—continuous near the pole and occasional in lower latitudes."

It is sufficient for the present purpose to know that the cause of the needle's diurnal variation is due in some way to the magnetic action of the sun upon the earth.

One certain evidence that the sun is magnetic and possesses powerful electro-dynamic energy is the mutual relation existing between the sun spots, the aurora and terrestrial storms, and the magnetic needle.

The sun spots have their periods of maximum and minimum appearances. During their maximum appearance the sun is never void of spots, from twenty-five to fifty frequently being visible at one time, but during a minimum, on the contrary, weeks often pass without a single one being observed. The average periodicity from maximum to minimum, and *vice versa*, is 11.11 years. What sun spots are is still a matter not fully determined, but it is known that they are caused by some commotion on the surface of the sun. The cause of their periodicity is also not yet understood. Sir John Herschel suggested that they might be caused by swarms of moving meteors moving in oval orbits with 11 year

periods. Professor Young, however, thinks otherwise. He says: *"Probably, however, the most general impression is that this rather irregular periodicity is more likely to be due not to external causes at all, but to something in the constitution of the photosphere and the rate at which the sun is losing heat: a gathering of deep lying forces during a period of outward quiescence followed by an outburst which relieves the internal strain."

Of the terrestrial influence of sun spots Professor Young writes: "One correlative of sun spots with the earth is perfectly demonstrated. When the spots are numerous, magnetic disturbances (the so-called magnetic storms) are most numerous and violent upon the earth, a fact not to be wondered at since violent disturbances upon the sun's surface have been in many individual cases immediately followed by magnetic storms, with a brilliant exhibition of the Aurora Borealis. The nature and mechanism of the connection is as yet unknown, but of the fact there can be no question."

In two able papers prepared by Professor Loomis, a relation between sun spots, the aurora, and the variations of the needle, seems to be clearly proven. He says: †"The auroral maximum generally occurs a little later than the magnetic maximum, the average difference

* General Astronomy, p. 207.

† American Journal of Science and Arts, Sept. 1870 and April 1873.

amounting to one year; while the time of aurora minimum either coincides with the magnetic minimum or slightly precedes it, the average difference amounting to about half a year. On the whole there seems to be no room for question that the number of auroras seen in the middle latitudes of Europe and America exhibits a true periodicity, following very closely the magnetic periods, but not exactly copying them. In particular we notice that during these periods in which the range of the magnetic declination was unusually small auroral exhibitions were extremely few in number and insignificant in brilliancy. If now we inquire as to the probable connection between these three classes of phenomena we cannot suppose that a small black spot on the sun exerts any definite influence on the earth's magnetism or electricity; but we must rather conclude that the black spot is a result of a disturbance of the sun's surface, which is accompanied by an emanation of some influence from the sun, which is almost instantly felt upon the earth, in an unusual disturbance of the earth's magnetism, and a flow of electricity, developing the auroral light in the upper regions of the earth's atmosphere. The appearances favor the idea that this emanation consists of a direct flow of electricity from the sun. If we maintain that light and heat are the result

of vibrations of a rare æther which fills all space, the analogy between these agents and electricity would lead us to conclude that this agent also is the result of vibrations in the same medium, or at least that it is a force capable of being propagated through the æther with a velocity similar to that of light. While this influence is travelling through void celestial spaces it develops no light; but as soon as it encounters the earth's atmosphere which appears to extend to a height of about 500 miles, it develops light, and its movements are controlled by the earth's magnetic force, in a manner analogous to the influence of an artificial magnet upon a current of electricity circulating around it."

It has been shown that the heat of the sun and the rotation of the earth give rise to two cyclonic hemispheres, one of these cyclones comprising the whole northern half of the earth and the other the southern half, and that the motions thus caused in the atmosphere produce an area of high pressure near the parallel of 30° in both hemispheres. A great many local cyclones occur every year in different parts of the earth, within the two great, or hemispherical, cyclones, but observation has shown that seldom if ever do they occur at the equator or the poles. They most generally commence in or near the belt of high pressure in the middle latitudes.

Whatever the sun spots may be it is a singular coincidence that they too have their origin for the most part in the vicinity of the sun's parallel of 30°, and afterwards they appear to move slowly, either towards the equator or towards the poles. Of the distribution of the spots Professor Young says :* "It is a significant fact that the spots are confined mostly to two zones of the sun's surface between 5° and 40° of latitude north and south. A few are found near the equator, none beyond the latitude of 45°."

This close relation between the region of sun spots and that of terrestrial cyclonic disturbances has attracted the attention of astronomers, and suggested a common origin. Professor Young says :† "Fay more recently has proposed and now maintains a theory which has numerous good points about it, and is accepted by many ; viz., that the spots are analogous to storms on the earth, being cyclones, due to the fact that the portions of the sun's surface near the equator make their revolutions in a shorter time than those in higher latitudes. This causes a relative drift in the adjacent portions of the photosphere, and according to him gives rise to vortices or whirlpools like those in swiftly running water. The theory explains the distribution of the spots (which abound precisely in the regions where this relative drift is at the maximum) and many other facts, such as

* General Astronomy, p. 200.
† General Astronomy, p. 203.

their 'segmentation.'" Professor Young shows, however, that whereas, if the spots are cyclonic, those in the northern hemisphere should gyrate in a clock-wise direction and those in the southern hemisphere in a counter-clock-wise direction, as a matter of fact they do not appear to have gyrations. He says also that there is usually "a ring of eruptions all around every large spot," all of them converging their bombardments upon the same centre. From this I infer that the appearance is somewhat like that of a calm spot in a caldron of boiling fluid with eruptions around it, from which the fluid flows into the depression from the elevations of bubbling liquid surrounding it, for he says: "Perhaps the true explanation may be that when an eruption occurs at any point, the photosphere somwhere in the neighborhood settles down in consequence of the diminution of the pressure beneath it, thus forming a 'sink,' so to speak, which is of course covered by a greater depth of absorbing vapors above, and so looks dark."

It appears that this explanation of Professor Young's is most reasonable. We know that if the sun's atmosphere is cyclonic at all the action must be violent and the matter be elevated to a very high altitude. The effect would be, therefore, more like a tornado that an ordinary cyclone, the horizontal component of motion being very limited and the perpendicular component

correspondingly great. The anti-cyclone area would, therefore, not be so distinct, and in a depression between several of these terrific tornadoes the denser matter would be likely to settle down without distinct gyrations.

The above theory leads unerringly to the hypothesis that on the surface of the sun, the same as on the surface of the earth there are two hemispheric cyclones, and that the sun's atmosphere, like that of the earth, is flowing eastward, and at some elevation from the sun has a much faster velocity than at the sun's surface.

Having demonstrated that the sun is a magnet constituted like the earth, and that with its heat and light it emits electricity also, we now enter upon the study of the sun as the central magnet of the solar system. The investigation can best be approached by reference to the laws of magnetic force as exemplified in the earth. Based upon the principle of electrical magnetic action that the needle seeks to go round an electric current clock-wise, we know, when the north pole (positive pole) of the needle points northwards that the surface electrical currents of the earth flow westwards. This leads to the conclusion that the magnetic force of the earth's field moves north, and thus it is proven that the geographical north pole of the earth is a mag-

netic south pole. Again following the law that whenever a magnet is brought into the magnetic field of another magnet its south pole will be attracted by the north pole of that magnet, and *vice versa*, the geographical north pole of the sun should be also its magnetic north pole. Now, if the law of the clock-wise rotation of the compass is applicable to the sun's magnetic field we know that as the geographical north pole of the sun is a magnetic north pole its equatorial electric currents must flow east. The sun is therefore in harmony with its electromagnetic constitution rotating on its axis from west to east, and carrying its magnetic field with it.

What shall we say now of the sun's magnetic field? It has already been shown that electric action is connected with the presence of æther, and that the magnetic action of any magnet is also dependent upon the motions of this same æther. As æther abounds throughout inter-stellar space we have the material for almost infinite magnetic action of an atomic character, and wherever there are large masses of matter so constituted as to form a centre of energy, this centre of energy when acted upon by another magnet, or when, through friction as the result of combustion or other forces its parts are set in motion electromagnetically it generates electricity and heat, and creates about itself a magnetic

field. Such a force is capable of infinite extension if its electromagnetic energy be sufficiently increased. Such a centre of energy is the sun. We know that its magnetic field reaches the earth because the latter's magnetism is affected thereby. It is evident also that as light and electricity are inseperably associated in nature, wherever the light of the sun penetrates there its magnetic influence is felt, though it would not, perhaps, be correct to maintain that the sun's magnetic field extends as far as its light, because when such a field is spoken of it implies only the area in which the æther is electromagnetically dominated by the central force acting upon it more than it is acted upon by any other force. This implies that the dominant æther is formed into lines of force about its magnet, but it can scarcely be said that the æther around distant systems of suns belongs to the magnetic field of our solar system, although the light of our sun may extend to them. There must be a dividing line somewhere between two systems of suns where it would properly be said that the field of one ends and the other begins. Although light and electricity may pass from one system to another, the point where one magnetic field ends and another begins we will designate, for expediency, as that where the predominance of the one system ends and that of the other com-

mences. Where the two systems are of equal area and strength, the line of division would be intermediate between the two, but quite frequently one system is subordinate, that is, it is wholly within the field of a stronger magnet, as previously shown by a smaller cyclone operating within the region of a larger one. If the solar system be taken in comparison with those systems of the fixed stars they must all be considered as co-ordinate systems, operating in spheres outside one another, but if the systems of the planets with their satellites be considered in relation to the magnetic field of the sun they are all subordinate and operate within the sun's field, being primarily dominated by the sun's magnetic energy. It must be readily apparent that throughout finite space wherever light goes, the æther is more or less affected, and being set in motion it becomes capable of transmitting energy. This energy is not transmitted instantaneously from the radiating body to the absorbing body, the velocity of light being approximately 186,000 miles per second. The propagation of this energy, as seen in the finite velocity of light, proves that æther has elasticity similar to that of solids, consequently it must have density. It has been shown also that the density of the æther is not of so evanescent a nature as many have supposed. The radiations of æther not only act

upon our senses, but they heat bodies which absorb them.

Now, if the æther fills inter-stellar and inter-planetary space, and is elastic, having an appreciable density even in the most remote regions, and if it is magnetically affected everywhere as demonstrated by the luminous radiations, then the only rational hypothesis is that by the tremendous radiations of the systems of fiery sun's throughout space stresses must be everywhere created in the æther which are most kinetic near the centres of disturbance and which decrease in their activity from the centre according to the law of the inverse squares. And also that, with the exception of calm belts which have been shown to exist between different systems, all the æther in inter-stellar space is swayed by one system or another. The nearest fixed star is 20 trillions of miles from the earth, or 230,000 times the sun's distance. This star (a Centauri) emits three times as much light as the sun. It must be inferred, therefore, that the star's magnetic field extends much more than half the distance from it to the sun, but to be sure of being within proper bounds, let us carry the boundary line of the star's magnetic field to a point three-fourths the whole distance towards the sun. The radius of the sun's magnetic field would then be 5 trillions of miles, or 57,000 times the distance of the earth

and 2,000 times the distance of Neptune from the sun. The numbers are beyond comprehension, but so is the propagation of light. The rapidity of the speed of light is incomprehensible to us, and when we remember that it requires $3\frac{1}{4}$ years for the light of the nearest star outside our solar system to reach us we may well be silent in the presence of so marvelous a power. Even the mention of the awful energy of the æther as witnessed in lightning and the electric current accentuates our sense of its strength. The magnetism of the æther in our presence is not only being affected by the sun but by stars thousands of billions of miles distant, and were it not for the stronger magnetism of the solar system the æther all around us would be attracted into the magnetic fields of their distant systems. It is no wild speculation, therefore, to suppose that the sun's field extends far beyond the orbit of the most distant planet. No, it is not even a theory, but a known fact established upon well known laws.

Chapter XII

Gravitation the Potentiality of Heat

In preceding chapters I have endeavored to show that the electromagnetic molecule and atom are physically constituted like the cyclone, and that in the constitution of matter there is embodied all the elements necessary for the force of gravity. In the beginning of Chapter X we have energy defined as being "The capacity for doing work." For the purpose of leading up to the subject of this chapter let us take up "energy" and divide it into its two forms, the only primary forms of physical energy of which we have any knowledge, —kinetic and potential. The energy which a system possesses in virtue of the relative motions of its parts is called "kinetic energy," and that which it possesses in virtue of the relative positions of its parts, is called "potential energy." Kinetic energy, therefore, is energy of motion and potential energy is energy of position. These two energies in any system are transformable the one into the other, and *vice versa.* If a stone is thrown into the air it has kinetic energy, but as it rises its kinetic energy is charged into potential energy so that when its highest point is reached its kinetic energy has all been spent, but because of the stone's position it has acquired potential energy and commences to descend to the earth. As it

falls it gains in velocity and thus its potential energy is again converted into kinetic energy. Therefore in any system the energy is sometimes largely potential, sometimes kinetic energy predominates, and at other times both energies are equal, but the sum of the two energies always remains the same.

We must now introduce some features connected with the principle of the conservation of energy. The stone alluded to above, in descending, reaches the earth and is brought to rest; but in doing so it appears to have lost both its kinetic and its potential energy. By the experiments of Joule, however, it has been ascertained that in such instances the energy is not lost, but is turned into heat. Therefore both the stone and the part of the earth where it struck are warmer than they were before. Joule proved that always a given amount of work entirely spent in producing heat produces the same quantity of heat, no matter how the conversion takes place. Watson says:

*"For instance, a given number of ergs which can be obtained from stopping a moving bullet and hence destroying its kinetic energy, will produce a certain amount of heat. The same number of ergs of work done in rubbing a button on a piece of wood will produce exactly the same quantity of heat. The energy in the form of heat possessed by a body is supposed to be due to the

* A Text-Book on Physics, p. 87.

motion of its particles. If this be so, then the kinetic energy of the stone moving as a whole is converted, by impact with the ground, into kinetic energy of the particles of the body and the earth near the point of impact."

There are many forces in the earth and various processes going on, but it is quite certain that we can trace them all to two primary causes: (1) kinetic energy with waves transverse to the direction of motion, of which only three forms are known, heat, light and electromagnetism, and (2) potential energy, which is always reactionary and gravitative. If thus the physical forces of the universe are reduced to their two primaries—two opposite forces—the difficulties of investigation become much simplified.

Of potential energy Professor Watson says: * "In the case of the bent spring, or in that of a stretched india-rubber cord, it is evident that the material of the spring or cord is in a state of strain, and it is owing to this strain that the body possesses potential energy. In the case of the raised weight, however, we are unable to detect any thing connecting the weight and the earth which is strained and which tends to revert to its former state, and thus endows the raised weight with its potential energy. If we were able to state what was the nature of the stress in this case, we should know the cause of gravitation.

* A Text-Book on Physics, pp. 85-6.

We are, however, unable to do this, and must content ourselves with saying that one portion of matter exerts force on another, and that it is to this force that their mutual potential energy when separated is due. We shall find that the theory that there is an all-pervading massless medium is necessary to explain the observed facts in heat, light, and magnetism and electricity ; we are not at present, however, entitled to say that it is to stresses set up in this medium that gravitation is due."

In the above paragraph Watson recognizes that in the case of the clock-spring and the stretched cord their potential energy is due to a tension among their parts. He admits that gravitation also, being a potential phenomenon, must likewise be a tension but is not sure that the stress is to be found in the "all-pervading massless medium" which is necessary to the phenomenon of heat, light and electricity. Here he falls into the error of most physicists in supposing that the æther is a massless, and consequently, a frictionless, medium. Scientists have been driven to that extreme view in order to account for the motions of the planets on the hypothesis of Newton's first law of motion, but on the hypothesis of their revolutions being within the sun's magnetic field, and the æther having mass and being subject to gravitation and the other laws govern-

ing matter, those difficulties vanish, and we are able to see what has not hitherto been understood, *i.e.*, that gravitation is due to a stress in the æther, giving rise to the mysterious phenomenon. We proceed to build our new theory of gravitation, therefore, on the electromagnetic molecule and the cyclone, taking as our basis the facts as already stated, that the kinetic energy of the system is due to heat, light and electricity, and that the potential energy, including gravitation, is simply a reactionary element consequent upon the kinetic energy.

In the cyclone the kinetic and potential forces are clearly defined in the cyclonic and the anti-cyclonic areas. The first of these areas is positive or kinetic, whilst the second is negative or potential. The first is the cause, the second is the effect. In magnetic action it is precisely the same. The motion in the magnet is the positive or kinetic energy, whilst the magnetic field is the potential or negative element in the system. It should be observed that in both the cyclonic and the magnetic systems, besides the primary kinetic and potential forces of the cyclonic and anti-cyclonic areas there are components of stress radially towards the centre and also away from it which act somewhat like centripetal and centrifugal forces. This principle was shown to exist also in the electric current, as there is force exer-

cised in the direction of the current and also in the opposite direction. Furthermore it can be proven that not only energy but matter also passes both ways in the electric current between two electrodes of a voltaic arc. Professor Chrystal, writing of this says: * "The hollowing out of the positive electrode is obviously due to a transfer of matter in the direction of the current. It is very easy to prove by a variety of conclusive experiments that there is such a transfer mainly in the direction of the current, but also in part in the opposite direction." The force which carries matter along in the current is kinetic energy, but that which carries matter in the opposite direction is potential energy.

Energy cannot be distroyed because action and reaction are equal: therefore every action, every kinetic force, must have somewhere, somehow, a correlative reaction—an equal potential force. It is so in the cyclone. It is so in the electromagnet. It is so in every continuous physical system. These two forces are absolutely essential to the physical couple without which no system can exist.

One of the greatest kinetic forces in the universe is heat. The potentiality of the cyclone is the anti-cyclone. The potentiality of electromagnetism is the magnetic field. But what is the potentiality of heat? Shall we say it has none?

* Enc. Brit., Vol. VIII, p. 59.

That would be to contradict a law which is otherwise universal. Heat has hitherto had no potentiality ascribed to it. We can point out a great many things which heat does but none of them, nor all of them combined, constitute an adequate potential force for heat. Let me repeat it! Heat in science is without a corresponding potentiality.

The sun and the earth are growing smaller and colder. Their energy in heat radiations is flowing out into space with but little apparent compensation. The most of it seems wholly lost. At least this is the verdict of science; but it is not altogether true. There must be a compensating effect, a potentiality, not yet discovered. The law of the whole universe demands it. It does exist and it is our duty to discover it.

It is important to observe that the kinetic and the potential energies of any system whilst being equal move in opposite directions. The one is opposed to the other in energy as well as in direction. Therefore heat and its correlate energy must move in opposite directions and also exercise their functions in opposition to each other.

In Chapter X it was shown that terrestrial heat is radiated from the earth outwards along the electric lines of force of the earth's magnetic field. It is a kinetic force whose power is hundreds of times greater than the strongest steel could sup-

port. Among other things which it does it elevates the atmosphere at the equator one-sixth higher than it would be if its temperature was the same as that of the poles. Heat being an energy which radiates outwards from the earth its correlative potential energy must proceed from some position above the earth inwards towards the earth. Is there any such a force known to science which is as universal as radiant heat? Yes, there is one, only one. Its law was first discovered by Sir Isaac Newton. It is a potential energy which has hitherto been as completely without a counter kinetic energy as heat has been wholly without a counter potential energy. Heat, the kinetic energy decreases from the earth inversely as the square of the distance and gravitation increases towards the earth from the position of a body separated from the earth inversely as the square of the distance. In these two forces we have a couple, a complete system as enduring as time.

There is sufficient proof in the abundant phenomena of nature to establish the hypothesis that heat and gravitation are the kinetic and potential forces of one system, being related to each other as cause and effect. Allusion has already been made to the repellent and expansive power of heat. As a result of loss of heat by radiation it is known that the sun is now contracting and its diameter decreasing at the rate of four miles every

century. Looking back into the distant past one must think of this contraction as always taking place, and of the sun as formerly having been much larger than it is now. Of this R.S.Ball says: *"Dealing then simply with the laws of nature as we know them, we can see no boundary to the growth of the sun as we look back. We must conceive a time when the sun was swollen to such an extent that it filled up the entire space girdled by the orbit of Mercury. Earlier still the sun must have reached to the earth. Earlier still the sun must have reached to where Neptune now revolves on the confines of our system, but the mass of the sun could not undergo an expansion so prodigious without being made vastly more rarefied than at present, and hence we are led by this mode of reasoning to the conception of the primeval nebula from which our system has originated."

The point which we wish to emphasize here in connection with the sun is its previous size and rarefied condition, and that the rarefying energy was radiant heat. In proportion as heat is present matter of every form is made more tenuous; and as matter is rarefied by heat the force of gravity between its parts is correspondingly weakened, because the molecules are farther apart, gravity being inversely as the square of the distance. But just in proportion as heat has been radiated

* Enc. Brit., Vol. XVII, p. 311.

from the sun the molecules composing it have settled inwards, the sun has grown smaller and denser, and gravitation has become stronger between the particles composing the sun. Not only so, but the denser particles have settled farther inwards forming the more solid nucleus of the sun while the atmosphere, the gases and the æther have been measurably forced farther outwards into the sun's photosphere and beyond, each in the order of its rarefaction.

Moreover this law works both ways. Therefore as the radiation of the heat from the sun weakens the heat force, thereby strengthening gravity and increasing the density of the matter composing the sun, a sufficient reapplication of heat to the sun should be able to rarefy it to its previous condition, to increase its diameter and to relatively weaken its internal force of gravity. There is full evidence that these results would follow a sufficient heating of the sun. We know that any solid substance may exist also as a liquid or as a gas. The earth was at one time a liquid and at a still earlier period it doubtless existed as gaseous matter. In either of these stages it had a much larger volume than at present. As a single instance of the power of heat to expand matter water may be cited. This liquid when converted into steam expands to 1650 times its original volume.

The phenomenon of gravity is that of bodies falling to the earth by attraction. In principle the law of gravitation is universal. Every particle of matter attracts every other particle. But in practice the law has its limitations. We are lla familiar with the Archimedean law that when a body is less dense than the medium which surrounds it the phenomenon of attraction vanishes and one of repulsion succeeds it. The body then recedes from the earth instead of falling to it. In nature only bodies obey the law of gravity when they are more dense than the air or other medium in which they are immersed. It is a daily occurrence that water when heated is repulsed from the earth by evaporation, and the same water again when cooled is condensed and falls as dew or rain. This law is not only true of water but it is also true even of the metals. When any of them are subjected to certain degrees of heat they become liquid. Then "These liquids when exposed to higher temperatures, some sooner others later, pass into vapours." At this point they ascend and present the phenomenon of being repelled. No doubt if they could be collected and condensed under sufficient pressure they might be again reduced to their original forms and present the phenomenon of being attracted.

In the case of a body being repelled by the earth because it is less dense than the atmosphere we do not need to assume that gravity has been suspended, but only that it has been overcome by a stronger force. Yet, from the practical standpoint the Archimedean law may be a more correct form of expression than the generally accepted statement of gravity.

Not only are we taught that all bodies attract one another but that "A body dropped from a point above the surface of the earth always falls in a straight line which is directed towards the centre of the earth." This also is a convenient statement for a principle but in practice it is not strictly true. The force of gravity is surely exercised in a straight line from the falling body towards the centre of the earth, but not all falling bodies follow this line. It is a daily occurrence to see light bodies falling in directions considerably inclined from the perpendicular. It is also a well known fact that a body falling from a high elevation strikes the earth at a point a little east of a straight line to the centre of the earth, because it has an eastward momentum. These allusions are brought forward here because we hope to show that bodies gravitate only in the direction determined by the components of motion and pressure.

In the discussion of the electromagnetic constitution of matter it was shown that every natural system, as the molecule, the planet and the sun, has around it an ætherial magnetic field, every part of which is in a definite and uniformly steady strain, so that there is no interruption throughout its entire area. Thus there is a steady pressure which increases from the circumference of the field towards the centre of the magnetic system inversely as the square of the distance. Now, while this strain remains equalized in the strength of its energy and normal in the direction of the force exerted, there will be no gravitation phenomena, as can be shown by a diamagnetic body remaining unaffected in a homogeneous electromagnetic field. But let something enter that field which destroys its homogeneity and otherwise creates inequality and irregularity of stress, and the phenomena of gravitation and of repulsion will be produced. In the physical systems of the universe heat is this great disturbing force.

In every system heat, in a greater or less degree, is generated and radiated. Scientific experiment has demonstrated that all solid bodies radiate heat. This heat is sometimes generated in the body; at other times it is absorbed from an outside source and emitted as radiant heat; and in other instances it is merely reflected heat. In any of these instances the effect upon the ætherial

and atmospheric field of the body is the same. The equilibrium of the field—the atmosphere, the gases and the æther—is disturbed, and the elements are either repelled or attracted according to the Archimedean law. If there is repulsion in one part there must be a corresponding attraction in another part.

As a first demonstration of how heat causes gravitation let us take the atmosphere of the earth. If the sun's heat were withdrawn the air all around the earth at any given altitude should be uniform in density and in the pressure exerted upon it. If the earth were at rest there would be no occasion for the air to be in motion. No part of it need change its position because the stress would be equal in all directions. But when the sun's heat is turned on a change occurs. The air becomes heated in the regions about the equator while remaining comparatively cold near the poles. The equatorial air is rarefied and rises one-sixth higher in altitude than the polar atmosphere. Thus the isotherms at the equator are raised and a descending gradient towards each pole is formed. When the hot air rises it meets resistance in the upper and colder altitudes, and is forced out on either side of the equator towards the poles and flows down the descending isotherms as down an incline. In brief the equilibrium of the earth's atmosphere is

destroyed, unequal pressure gradients are everywhere created, the result being that the hemispherical cyclones are formed, as shown in a previous chapter. The change of position of the molecules has caused a partial vacuum in the lower strata previously occupied by them, and also produced an abnormal pressure in the new position which they have occupied. Consequently the combined pressure of the system seeks to re-establish uniform pressure in the disorganized portions by forcing the air from the upper and overcongested position where a pressure above the normal has been created to the lower semi-vacuum position from whence the hot air escaped and which now is unable to support the normal pressure of the system. Therefore the congested molecules of the high altitude present the phenomenon of falling to some point below, at or near the earth. But the pressure on them is so slight above the average and the directions of the strains are such that they cannot fall directly towards the centre of the earth. Therefore they must pursue a path which lies in a circuitous direction, out polewards, inclining downwards, and back towards the equator again, until the earth's surface is reached. These molecules of air have made a journey into high altitudes and have been attracted back to earth by the law of gravity, one factor being a scarcity of air near the earth and pressure

exerted from above. The forces which performed the ascent and descent of the molecules were three—a pressure everywhere in the atmosphere, and the kinetic and the potential energies of heat working in a cyclonic system.

The base of the terrestial cyclone in which what has been narrated occurs is not on the earth but out beyond the pole, and the primary stresses are parallel with the surface of the earth rather than perpendicular to it, but notwithstanding these conditions the atmospheric molecules obey the forces of the cyclone quite independently of any other force of gravity.

We look now at the secondary cyclone whose base is at the surface of the earth and whose principal stresses are more perpendicular to the earth. In the centre of the cyclone the air ascends almost perpendicularly, and as is the case in the terrestrial cyclone it is forced back to earth in the anti-cyclonic area partly by increased pressure above and diminished pressure below. The area is smaller than that of the terrestrial cyclone and the molecules fall more directly downwards, but in doing so they gyrate several times around the cyclone horizontally. This descending air is generally supposed to fall by the action of gravity, but it does not obey the law in falling straight towards the centre of the earth. It is quite evident also that the primary forces operating to attract it

to the earth are the forces of the cyclone which have their source in the kinetic and potential energies of heat radiation.

In the tornado the energy is stronger and the direction of motion still more perpendicular. The funnel is long and slender and the ascending current rises to a great height. The rising current is thrown more nearly back upon itself and the descending air is forced almost straight downwards to fill the vacancy at the surface of the earth, with but little gyratory motion. This instance much more nearly conforms to the phenomenon of gravity, but it also is only another example of gravitation due to motions which originate in heat radiation.

Now we hope to be able to show that something similar to the ascending kinetic and the descending potential energies of heat witnessed in the cyclone occur in the phenomenon of every falling body. Allusion was previously made to the scientific deduction that every solid, no matter how cold it may seem to be, nor how much heat it may be absorbing, always radiates heat from every part of its surface, because solids absorb, hold temporarily, and then radiate heat, while the heat radiations pass on through the more tenuous substances without warming them so much. Scientists tell us that the temperature in inter-stellar space is about 412° below zero, Fahrenheit. This being hundreds of degrees colder than any place on our

globe heat must be continuously leaving even the coldest parts of the earth and passing out into distant regions.

If we take now any part of the earth's surface we find that the heat radiations produce a comparatively uniform strain in a medium already strained by electromagnetic pressure, in addition to the cyclonic stresses. The tendency of the heat strain is to force the whole fluid field of the earth outwards, and waves are formed in the medium which is comparatively homogeneous. At this stage if a body be introduced into the field which disturbs or destroys any part of these waves thereby producing a heterogeneous strain something must yield. It depends wholly upon the nature of the body as to what the effect will be. If the body is considerably more dense than the medium in which it is placed it will fall straight to the earth and fulfil the requirements of the law of gravity. The principal reasons for this we think, are two.

First, the dense body stops some of the heat by absorption. Some of the ætherial particles, which have been shown to be the agents of heat radiations, are absorbed by the body and temporarily retained, their radiating energy being thereby checked. Others of them which do not enter the body are thrown back, reflected, and their radiations turned in the opposite

direction. The effect is to elevate the isotherms and cause a relatively rarefied condition of the atmosphere and æther on the side of the body facing the earth. This place therefore becomes a partial vacuum into which the body tends to fall in the direction of the earth. In consequence of the radiations being obstructed the strain outwards, continuous elsewhere, is weakened on the upper or outward side of the body, and this weakening effect affects the medium on that side of the body clear through to the circumference of the earth's field. The effect is precisely that of a shadow which a dense body casts in the sunlight. It has been proven that radiant heat casts a shadow like light, although we do not discern it with the naked eye. Therefore, every substance denser than air, when raised from the earth, casts a shadow away from the earth because it stops more radiant heat than the atmosphere does. The isotherms are not elevated on the shaded side so much as they are on the other side of the body. The fluid in the shadow is cooler and denser, and the depressed isotherms form a sink into which the tenuous matter flows with a descending energy, because the upward energy of the waves react into it. The strain of the entire system now exerts itself on this weak point in the earth's field and the body is forced downwards

with an ever increasing velocity and momentum. This principle operates in the magnet, the cyclone, the tornado, in gravity and all similar phenomena. It was first demonstrated in an experiment by Sir. W. Thomson, as follows: "A tuning-fork is set in vibration, and brought near a delicately suspended light body. The body is immediately attracted towards the tuning-fork. If the tuning-fork is itself suspended, it is seen to be attracted towards any body placed near it. Sir W. Thomson also succeeded in producing repulsion in the case of a small body lighter than the surrounding medium."

Second, the inertia of matter has perhaps a greater influence upon gravity than any other agent. The tuning-fork experiment and the cyclone show that dense matter moves towards the centre of a wave disturbance because there is less pressure on that side than on the other, but in the case of gravitation it may be doubted whether this alone is sufficient to produce the phenomenon. There can be no question however about all the elements being present. There is a fluid limitless in extent, and under pressure in all its parts. And in the centre we have the earth, a great body all of whose parts are in motion, sending out waves of immeasurable energy to an unknown distance—waves whose energy is most intense in and near the earth.

Investigation has demonstrated that the temperature of the earth increases from the surface towards the centre, the interior being very hot. In addition to a continuous active radiation from this source a great deal of heat is received from the sun and radiated. But if there are any doubts whether the difference of pressure on the two sides of a falling body is sufficient to produce the phenomenon of gravity the second reason can be put forward confidently as being a strong force co-operating with the first, if not itself the principle cause of gravity.

"Dr. Robert Hooke, a man of singular inventive power, in 1671 endeavored to trace the cause of gravity to waves propagated in a medium. He found that bodies floating on water agitated by waves were drawn towards the centre of agitation." It does not seem that a body floating on water would be drawn towards the centre of agitation for exactly the same reasons as those of a body drawn towards the tuning fork. One cannot readily see how there could be a sufficient vacuum formed on one side and increased pressure produced on the other when the waves were those of the water while the floating body was largely in the air above. On the contrary the motion of the wood towards the centre of agitation can best be accounted for by the inertia of the wood. In the

first place the wood was at rest. When the outgoing wave struck it some time was required for the energy of the wave to be imparted to the wood and before it could move outward the incident wave had already passed and a reflex wave was returning. The wood also had by this time reacted and begun to move towards the centre of disturbance on the reflex wave. Having now acquired a motion in that direction it readily passed over the next outgoing wave and continued moving towards the centre.

I have made several experiments in connection with the study of gravitation, but one of the most satisfactory results yet obtained was with a block of hard smooth wood several inches long. It was firmly held in one hand horizontally and two bodies, one a small weight of metal or wood and the other a tiny bit of paper or other very light material placed upon it at opposite ends. Then when tapped lightly on the end where the light body was situated the heavy body moved towards the disturbance while the light body moved away from it.

The principle involved in the moving of the two bodies in opposite directions on the wooden surface is one of wave energy, density and inertia. The density of the large body gave it too much inertia to permit it to be carried forward by the wave motion of the wood when struck, but

instead, as explained in connection with the wood floating on water, the body swung backwards toward the point of disturbance. And the light body not having inertia to resist the energy of the wave motion of the wood was carried along towards the far end of the block, in opposition to the larger body.

Physics teaches us that in any liquid or fluid at rest the pressure on all sides of any small portion of it, as a molecule, is equal. We ask then why is not the pressure equal on all sides of a light molecule of gas when surrounded by the atmosphere? And if the pressure is everywhere the same why does it change its position, rising upwards? None of the usual gravitation answers can be entertained unless accompanied by a demonstration of what gravity is. Why also does the dense body set free in the atmosphere, around which atmospheric pressure is everywhere equal, fall to earth? Our answer is that these phenomena are primarily because all matter is in motion. All the stresses of which scientists have knowledge are ascribable to the motions of matter. The ascent of the light body and the descent of the heavy body are both due to the motions of the earth and its field. The stress in the atmosphere and æther extends as far radially as the earth's field, and every molecule and atom in the homogeneous field acts and reacts in

symphony with the heat waves of its individual stratum. If, when struck by a heat wave radiating from the earth a body has not sufficient density to give it the proper inertia and reactionary power it will act too easily and be pushed upwards, and the entire radius of that portion of matter outwards will be weakened thereby and the matter in the lower strata will move upward carrying the tenuous body with it until met by a sufficient reactionary force from above. In any reflex movement much depends upon steadiness and solidity, and these come from density. Therefore if a body is borne upward because it lacks density sufficient for a necessary reactionary force what will a body more dense than the atmosphere, a body capable of more inertia and more reactionary force than the radiating wave possesses, do when struck by the wave? Contrary to the light body it will not act quickly enough for the wave and, from the point of incidence to the outward terminus of the radius, the matter and resisting force will be increased by the excess of matter in the dense body. Consequently at the place of incidence the wave will slightly yield and pass around the body, while the body, as demonstrated in the illustrations, will move towards the centre of disturbance —in the case of gravity earthward.

In concluding this chapter I desire to present the results of another of my own experiments in

confirmation of the above theory of the cause of gravitation. I found that a strip of paper, a cork, or other light body suspended by a thread two feet or so in length and held near a radiating surface, as a hot stove or other similarly hot body, was attracted to the body, but more remarkable still when the cork was brought into the vicinity of a reflecting surface from one to three feet away from the radiating body, it was attracted to the reflecting surface quite as decidedly as it had been to the hot body before. These results are in full accord with those of all the other experiments cited in the preceding pages.

Summing up the results of this whole subject we are led to the conclusion that the molecule, the earth, the sun, have nuclei of dense matter, each of which is magnetic. Each of these nuclei has also a magnetic field whose electromagnetic intensity is inversely as the square of the distance. Also each solid nucleus generates, absorbs, emits and reflects heat. Consequently solids do not conduct heat as readily nor as fully as æther, the medium of radiation. The radiant waves are possessed of energy which reacts towards the centre of disturbance, the reflex wave being a little colder and denser than the radiated wave. Much experience proves that the law governing such action is that bodies less dense than the medium which surrounds them are carried away

from the centre of disturbance, while bodies more dense than the medium are precipitated towards the centre of disturbance, the phenomena being caused by radiating heat. This is conformable to the Archimedean law which is the true law of gravity.

It seems therefore that nothing more is required to demonstrate the nature of gravitation and to locate its source than is herein presented. If this scientific view of the forces which produce gravitation be accepted the phenomenon becomes as simple as any other scientific fact.

Most of the argument of this chapter has related primarily to the potential force called gravity, and indirectly to other forms of potential energy but the kinetic energies of all physical systems—heat, light and electromagnetism—are themselves potentialities of some other energy. Of this I shall speak later in the proper place.

Chapter XIII

The Planets in the Sun's Magnetic Field

In the progressive unfolding of the plan of the universe in harmony with the principles involved in the electromagnetic constitution of matter, we have been led up, step by step, from the ætherial atom to the massive and extensive magnetic orb occupying the central position in our solar system. It has been known for many centuries that the sun, planets, satellites and asteroids form one system, and since the days of Newton the world has been content to accept the theory propounded by that eminent philosopher based on two hypotheses: (1) that all bodies in the universe attract all other bodies with a force proportional to the mass of each respectively, and (2) that a body once set in motion will continue to move forever in a straight line, as provided for in the First Law of Motion, unless stopped by an opposing force. From these two hypotheses Newton formulated a theory for the revolutions of the planets around the sun by a resolution of the two forces—the centripetal force, depending on gravitation, and the centrifugal force, depending on the First Law of Motion.

The mathematical demonstrations made by Sir Issac Newton and his contemporaries, as based on the above theory, were correct, and the world

owes them an incalculable debt of gratitude for their great discoveries, but it should be remembered that they did not prove the First Law of Motion nor assign any reason for the law of gravitation; morever Newton frankly disclaimed any knowledge of the cause of gravitation. He simply claimed to have mathematically demonstrated that such a force as gravity does exist. Our purpose in this work has been not to disprove what Newton mathematically demonstrated, but rather to find a physical cause for his ascertained phenomenon. This we think has been accomplished, and whilst his mathematical work remains unchallenged it appears doubtful whether there is now any necessity for his theories as set forth in the First Law of Motion concerning a body moving forever, as applied to the planets.

Since it has been ascertained by the transmission of light in ætherial waves that there is matter throughout stellar space and that it has density and elasticity similar to solids, it has been very difficult to reconcile various phenomena with Newton's First Law of Motion, because it is not apparent how such a substance can exist and be frictionless; and if it have friction it would doubtless tend to retard the centrifugal motions of the planets and to precipitate them into the sun. Therefore, various theories have been devised, such as that the æther must be frictionless so as

to slip around the celestial spheres when they move forward, or that it goes through them like wind through the branches of trees; but none of these theories accord with the phenomena of light. If æther be frictionless, or have no elasticity, or finite density, it cannot be the medium of waves which we know exist in the transmission of light, electricity and heat. Many scientists are therefore at the present day looking about for a more intelligible hypothesis of planetary action than that which Newton's theories afford. Dr. Larmor, in his address to the British Association, 1900, said: "There has even appeared a disposition to consider that the Newtonian principles, which have formed the basis of physical phenomena for nearly two centuries, must be replaced in these deeper subjects by a method of more direct description of the cause of the phenomena. The question has arisen as to how far the new methods of ætherial physics are to be considered as an independent departure; or how far they form the natural development of existing dynamical science."

Newton advanced the corpuscules theory of light, which taught that light was due to the emanation of atoms of matter which, having been thrown out from the sun, travelled in straight lines to the earth and coming in contact with the eye caused the sensation of light. This theory, which

it seems, is an idea closely associated with that embodied in the First Law of Motion, held a prominent place in the minds of physicists for a hundred years or more, but owing to the advance of physical science as regards the ætherial waves it was finally disproved by actual experiment. It is not improbable, therefore, that as we come better to understand the kinetic and potential energies of matter, as exhibited in the electro-dynamic constitution, it will be ascertained that Newton's First Law of Motion theory, and also his ideas of gravity, will have to be somewhat modified.

In accordance with the electromagnetic theory of the constitution of matter we find that the planets are magnetic, each possessing its own magnetic field, situated in the greater magnetic field of its primary magnet, the sun. It is in harmony with scientific laws for one sphere within the field of a primary to have a field of its own. A large cyclone with two smaller ones is shown in Chapter X, Fig. 15. One of these latter is fully developed, with its cyclonic and anti-cyclonic areas, in some instances moving in direct opposition to the atmosphere of its primary. Again, take the more familiar instances of magnets with their magnetic areas operating in the terrestrial magnetic field. We cannot doubt, therefore, that the earth, being a great magnet within the magnetic field of the sun, is perfectly competent

to have a field of its own extending far beyond the confines of the moon.

The moon sustains a relation to the earth somewhat similar to that which the earth bears to the sun. It revolves around the earth, crossing and recrossing the ecliptic, oscillating on each side of it to a distance of about 5°. Professor Young, writing of the lunar influences on the earth, after referring to the moon's relation to the tides, says: * "There are also certain distinctly ascertained disturbances of terrestrial magnetism connected with the approach and recession of the moon at perigee and apogee." This proves that the moon has a magnetic field, inside the field of the earth, whose effects are felt at intervals as far as the surface of the earth. It is therefore reasonable and scientific to maintain that the earth has a magnetic field the boundaries of which extend some distance beyond the orbit of the moon.

There are two forces which, in large measure, determine the relative positions of the planets in the sun's field. These are density, and magnetic permeability.

The magnetic field of the sun is a fluid medium; consequently Archimedes' principle of hydrostatics applies to the planets which are immersed in it. Archimedes, about 250 B.C.,† "Maintained that each particle of a fluid mass, when in equilibrium, is equally pressed in every direction; and he

* General Astronomy, p. 174.
† Encyclopedia Britannica, Vol. XII, p. 435.

inquired into the conditions according to which a solid body floating in a fluid should assume and preserve an equilibrium." From his principle we get the following proposition: "The resultant pressure of a fluid on a body immersed in it acts vertically upwards through the centre of gravity, and is equal to the displaced liquid." For instance: "The weight of water displaced by a ship is equal to the weight of the whole ship, masts, rigging and all. When a balloon is at rest in the air, the weight of the balloon is equal to the weight of air displaced." Therefore, if the theory of gravitation and the magnetic field of the sun herein advanced is true each planet must displace a portion of the fluid of the sun's field equal to its own weight, including the weight of its own magnetic field. It is immediately apparent, therefore, that the densities of the planets will be one principal factor in determining whether they should be near to or far away from the sun.

It is doubtless already apparent to the reader that in the sun's field the mass at the centre is much more dense than that at the circumference, and consequently there is a regular gradation of density in the intermediate fluid. This being true, each planet seeks a position in the sun's field corresponding to its own density, as heretofore demonstrated in the experiment showing that heat

radiations cause dense bodies to press harder towards the centre of radiation than bodies less dense.

One's first impression may be that dense bodies like the earth could never be supported in a rare medium like æther, but subsequent reflection should be sufficient to remove all doubt. That we may arrive at a conception of the relative sizes of the different members of the solar system and the position each occupies therein we cannot do better than to quote from Sir J. Herschel, as follows: "Choose any well levelled field. On it place a globe two feet in diameter to represent the sun; Mercury will be represented by a grain of mustard seed, on the circumference of a circle 164 feet in diameter for its orbit; Venus a pea, on a circle 284 feet in diameter; the earth a (somewhat larger) pea, on a circle of 430 feet; Mars a rather large pin's head, on a circle of 654 feet; the asteroids grains of sand, in orbits of from 1000 to 1200 feet; Jupiter a moderate sized orange, on a circle of half a mile; Saturn a small orange, on a circle of $\frac{4}{5}$ of a mile; Uranus a full-sized cherry, on a circle of more than $1\frac{1}{2}$ miles; Neptune an extra-sized cherry, on a circle of $2\frac{1}{2}$ miles in diameter." One can but be impressed by the smallness of the planets as compared with the sun, and their relatively great distance from it. The logical conclusion is therefore that the planets, being so small, comparatively, and possessed of

relatively strong magnetic powers, are able to hold in their embrace a magnetic field sufficiently large to bear them up in the different strata of the sun's magnetic field, while they rotate on their respective axes. The same philosophy applies to the satellites rotating in their respective magnetic fields of the planets. The moon, therefore, is borne up by and in the earth's magnetic field.

This hypothesis of the planets being borne up by the different strata of æther in the sun's magnetic field coincides nearly with their relative positions in that field when compared with their respective densities. There is room for some doubt about the absolute correctness of the densities of certain of the planets because astronomers do not fully agree, but their disagreements are comparatively insignificant. We append three tables below showing their several densities. The first is by Archibald Geikie, F.R.S., Director General of Geological Survey of Great Britain. The second is by R.A. Proctor, B.A., F.R.A.S., author of "Other Worlds than Ours." The third is by Charles A. Young, Ph. D., L.L. D., Professor of Astronomy in Princeton University.

Density of Mercury	earth as one	...	1.12	1.12	.87*
" " Venus	"	...	1.03	1.03	.88*
" " Earth	"	...	1.00	1.00	1.00
" " Mars	"	...	.70	.70	.73
" " Jupiter	"	...	.24	.24	.24
" " Saturn	"	...	.13	.13	.13
" " Uranus	"	...	.17	.17	.22
" " Neptune	"	...	.16	.16	.20

* Prof. Young says these are uncertain.

The above tables show that, with slight irregularities, there is a progressive increase in the densities of the planets the nearer they are to the sun. This is what we should expect to find. Numbers 1 and 2 of the tables exactly coincide and, in them, from Neptune the most distant planet to Mercury the nearest one to the sun, there is an almost uniform increase of density, except in the case of Saturn which is lighter than Uranus and Neptune. If we take the densities of the planets alone, it might be maintained, with some show of reason, that one exception to the rule like that of the third planet from the most distant being lighter than the two more distant ones, destroys the theory that the planets float in the ætherial strata of the sun's magnetic field. But it should be observed that we also have to reckon with another determining factor; that is magnetic permeability.

Magnetic Permeability doubtless has a considerable influence in determining the positions of the planets. Without magnetism it would be more difficult for celestial bodies to carry with them through space and in their axial rotations extensive areas of ætherial fluid. Experiments have proven that not only the strength of a field is affected by the strength of a magnet but that its dimensions also are extended or contracted as the magnetic strength is stronger or weaker. Thus a

minor magnet in the field of a primary one, or *vice versa*, may be attracted or repelled in proportion as the magnetic strength of either magnet is increased or diminished. Interesting experiments which demonstrate the truth of the above have several times been performed by the writer.

For the experiments two bar magnets about five inches in length were used. One of the magnets weighed 120.4 *momme* (Japanese weight) and the other 20.3 *momme* (120 *momme* equal 1 lb. avordupois.) A letter scale, tested by the government, was used. First the larger magnet was placed upon the scale and the smaller one adjusted half an inch above it, lengthwise, opposite poles in conjunction. The beam immediately fell and it was ascertained by readjusting the scale that the large magnet had lost 2 and $\frac{4}{10}$ *momme*, or about $\frac{1}{50}$ of its entire weight. Then the smaller magnet was placed on the scale and the larger one placed one half inch above it, as in the preceding case. The smaller magnet now lost 2.4 *momme*, the same amount the other had lost, but in this instance the loss was about $\frac{1}{10}$ of the entire weight of the small magnet. This experiment showed that the attraction of the large magnet for the small one was equal to the attraction of the small magnet for the large one. They harmonize in this respect with the law of gravity. When like poles were placed in proximity the

repulsions were marked but not so strong as the attractions had been. The experiment was tried with unmagnetized iron of weight equal to the magnet it displaced. The action was the same in all respects as when two magnets were used, except that the iron was not attracted nearly so forcibly and consequently did not lose so much in weight as the magnet had done.

A similar experiment with like result was also made by swinging one magnetic needle by a slender thread from a fixed point above. When the other needle was brought near the suspended needle the first needle took up a position a little nearer it, drawing the thread by which it was suspended out of the perpendicular.

The Archimedean principle of hydrostatics applies to magnetic permeablity as well as to density, and we see from the greater attraction of a magnet for a magnet than of a magnet for unmagnetized iron, that a minor magnet would take up a position in the field of a primary magnet in closer proximity to the central magnet than the unmagnetized iron would do; viz., the magnet would be in equilibrium in a lower and more magnetic stratum in the magnetic field than iron would be. Moreover, if the magnetic susceptibility of either magnet, or if the iron, should be changed their relative positions in the magnetic field would be correspondingly changed. The

position which a planet will occupy in the magnetic field of the sun must, therefore, be determined by the combined influence of its density and its magnetic susceptibility.

We may, therefore, safely assume that the stronger magnetic planets occupy positions nearer the sun than they would do if they had no magnetism and the more weakly magnetic ones more distant positions. It was demonstrated in the chapter on paramagnetics and diamagnetics that this would be the action of bodies in a magnetic field, when they were magnetic in difference of degree. This law of magnetic action is thus shown to be fully sufficient to account for the somewhat irregular positions of the planets, as relates to their densities, in the solar system.

It may be that several influences combine in causing the ellipticity of the orbits of celestial bodies. One cause is probably the momentum of the revolving body. The common theory is that the momentum of the body gives rise to an alternate ascendency of the centripetal and the centrifugal forces, thus carrying it farther away from and then nearer to its primary. The same might be true in a degree when the planets float in the magnetic field of the sun. A solid mass floating in a fluid always moves with a greater momentum than does an equal mass of the fluid whose molecules are free to move at random.

This is seen in the action of bodies floating in currents which have curves in them. A piece of timber, for instance, has often been observed to pursue a straight course and run into the bank of a curved stream with great force whilst the water swung round the curve and passed on down the stream. The earth, including its magnetic field, constitutes one system of energy and would act in the field of the sun much as would a solid of similar mass and dimensions.

It has been proven that a body dropped from a high altitude will fall a little east of the perpendicular from whence it started, because of the momentum it possessed by virtue of the earth's rotation. The rotatory motion of the earth at the equator is only approximately one thousand miles an hour while its orbital velocity is about 63000 miles per hour. It must be presumed, therefore, that the earth's momentum would have some tendency to carry it out beyond its normal stratum in the æther and when reaction set in to precipitate it farther in towards the sun than the normal position. Its orbit would, therefore, be an ellipse, and the eccentricity, perigee and apogee, would present the phenomena now known to exist.

We already understand the meteorological phenomena constantly occurring in the atmosphere, how radiation keeps up a flow of air

from the equator, in high altitudes towards the poles, resulting in two great terrestrial cyclones, each covering half the earth. It was shown also that whereas the atmosphere near the surface of the earth moves with an average easterly velocity but little exceeding that of the earth the velocity at an altitude of $2^1/_2$ miles, in an easterly direction, is, on an average, about twenty-five miles per hour faster than the motion of the earth at the equator. This easterly component of motion is fostered by the sphericity of the earth. The atmosphere which moves poleward from the equator constantly moves from a parallel of faster rotatory motion than that of the parallel toward which it is moving. Consequently, it gains a faster velocity than that of the earth at the same parallel. Therefore, the entire atmosphere of the earth, to a very high altitude, acquires a velocity, in an easterly direction, far exceeding the velocity of the atmosphere at the surface of the earth. The principal cause of all this motion is unequal expansion of the atmosphere, in consequence of equatorial regions receiving more heat than do other latitudes.

Now, it is easy to see that if the æther is affected by heat in the same manner as the atmosphere, conditions not unlike those existing in the air are likely to be created in the æther composing the magnetic field of the sun and also of the earth.

There is abundant evidence to show that aether is affected by heat like other forms of matter. Heat weakens magnetic energy; causes ætherial waves by radiation; it is one of the phenomena of light; and is universally present in electrical action. The heat of the sun so affects the æther that there are diurnal changes in the compass. Thus the way is prepared for us to believe that the earth's ætherial isotherms on the side facing the sun, especially in equatorial latitudes, are elevated like the isotherms of the atmosphere and that the æther in very high altitudes tends to move towards the poles just as does the atmosphere. In lower latitudes it would incline to move towards the equator; therefore, a kind of ætherial cyclone would be created in each hemisphere of the earth's magnetic field.

If this hypothesis is correct the æther enveloping the earth is not only rotating with the earth, but in high altitudes, probably for some distance beyond the limits of the atmosphere, it is rotating faster than the rotation of the earth. A natural ætherial flow is therefore produced around the earth, which, after a certain elevation is reached, flows slower and slower until a point is attained where the æther is unaffected and remains at rest. This kind of an ætherial flow is natural, and instead of retarding the rotation of the earth is, on the contrary, a distinct aid to it. This hy-

pothesis is not inconsistent with the electro-magnetic lines of force of the earth's field. This is demonstrated by the atmosphere; it is paramagnetic only in a less degree than the æther, and it has cyclonic motions as well as magnetic susceptibility. Of course, in the case of the æther the molecules or atoms, whilst being moved poleward or eastward, as a result of unequal and variable density, must in great measure maintain their polar directions in harmony with the magnetic lines of force, so they can continuously transmit magnetic energy, thus maintaining the magnetic lines of force of the earth's field. Conditions exist in the sun's field similar to those in the earth's field.

We have now a magnetic field with an eastward velocity, capable of supporting the planets and carrying them along in their revolutions. (The moon is transported around the earth, also, in the earth's magnetic field.) Therefore, from a not too high altitude in the photosphere of the sun to the extreme limit of the sun's magnetic field there is a gradual decrease in rotational velocity until the circumference of the sun's field is reached, where the rotational motion of the æther ceases; consequently the planets nearest the sun should travel faster than those more distant from it. This hypothesis is confirmed by the following table:—

Name of Planet	Mean Distance from the Sun	Mean Daily Motion in Time	Daily Motion in Miles
Mercury	35,392,000	14,372.41′	2,526,500
Venus	66,134,000	5,767.66	1,848,300
Earth	91,230,000	3,548.19	1,574,750
Mars...	139,311,000	1,886 51	1,273,500
Jupiter	475,692,000	299.12	689,960
Saturn	872,137,000	120.45	509,000
Uranus	1,753,869.000	42.23	392,530
Neptune	2,745,998,000	21.40	286,800

All of the observed phenomena of the solar system can be accounted for as well by the electromagnetic system as by the Newtonian theory. Two planets coming near together would magnetically affect each other, and cause local disturbance in their revolutions.

I am confident also that the several phenomena of the tides as originated by the sun and the moon; the changes in the tides depending on the declinations of the sun and the moon, and on the horizontal parallax of the sun, or on its varying distance from the earth when in perihelion or aphelion; or on the eccentricity of moon's orbit can all be accounted for by electromagnetic and hydrodynamic energy, but a minute discussion of those subjects is beyond the purpose of this book.

PART II

The Physical Proves the Existence of the Spiritual

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Chapter XIV

Matter is not a First Cause

In our study of systems composed of molecules we have ascertained that the stresses existing in organized matter are those pertaining to the cyclone and the electromagnet. Half the energy is kinetic and half potential; or, half is positive and half negative. We have learned also that the kinetic or positive energy of any system is not a first cause, but is itself produced by some antecedent energy. That this is true is clearly seen in the origin and continuance of the cyclone. The kinetic energy on which the entire force of the cyclonic and anti-cyclonic stresses depend is a result of heat radiation from the sun when reflected from the earth. Therefore, the cyclone, in its entire constitution, is an effect.

Another important evidence proving that matter is not a first cause is found in the fact that magnetic action is not spontaneous. Its origin is not internal but in every instance is external to the magnet. In Chapter VI, on Magnetism, it

was shown by a quotation from Professor Chrystal that every magnetic action is induced by another magnet. This is true of all magnets whether native, such as the loadstone, or artificial, such as the needles magnetized by rubbing with the loadstone. Therefore, "Every purely magnetic action in a magnet has its source in some other magnetic body."

One reason why an electric current will not continue to flow without a constant supply of energy from a dynamo, and why a magnet will not act without a continuous application of magnetic energy is because there is constant friction and inertia to be overcome. It has been shown that it requires energy more than what is inherent in a magnet to put the lines of force through its centre, from the negative to the positive pole. If this supply of energy from without is not constant the action of the magnet is correspondingly affected. It is evident, therefore, that not only is every purely magnetic action due to the presence of another magnet but also that there is a waste of energy in magnetic and electric action which has to be supplied from without to keep the power for doing work unchanged. This is equally true, relatively, whether matter be organized into a great centre of energy like that of the solar system, or an infinitesimally small system such as that of an aetherial atom, because the

principle governing the physical constitution of the one is the same as that governing the other. This makes clear at once why there is no such thing in the universe of matter as perpetual motion in an infinite sense.

This dependent action of the cyclone and the magnet as described above is a correct illustration of all the organized systems of energy in the physical universe. They must all have a feeder in order to exist for a great length of time, and when their source of energy is augmented they increase in strength and expand, but when the source of energy declines they also decline or deteriorate. The whole of the matter of the universe may be organized into myraids of magnetic centres all acting upon one another, or it may be organized into only a few centres of magnetic energy, the fact will still remain that either by combined or individual effort there is not power in matter to indefinitely perpetuate itself in organized form, because as every organized centre is dependent on an outside source of energy, and also as there is constant dissipation of energy from highly organized centres of matter to comparatively unorganized centres where uniformity of energy exists there is not in all the universe of matter a supply of energy for the visible creation, no difference into how many or how few individual centres it be constituted.

When we consider that matter is all electro-magnetically constituted and that each atom, molecule, world, and system of worlds, is dependent on a supply of energy from without itself, and that without that energy it will cease to exist as a force, we are at once compelled to admit that the universe, if left to itself, is like a clock running down. It is like an electric current which keeps up its strength and does a certain amount of work while the battery lasts, but whose battery is sending forth energy while its chemical constituents are gradually being decomposed and dead as concerns the electric energy represented in the battery. It is like a sun, which is a source of energy to a system like our own solar system, but which by and by, will become impotent to perform its work in the system, because, having parted with its energy as relates to its functions in the system, it has become dead in that system.

Scientists say that this dying process is taking place in our sun. Professor Young, writing of solar radiation at the sun's surface says :* "To maintain such a development of heat by combustion would require the *hourly burning of a layer of the best anthracite coal from 19 to 24 feet thick* over the sun's entire surface,—over a ton for every square foot,—at least ten times as much as the consumption of the most powerful blast

* General Astronomy, p. 239.

furnace in existence. At that rate the sun, if made of solid coal, would not last five thousand years."

Concerning energy developed by shrinkage Professor Young says:* "The kinetic energy developed by the shrinkage of a gaseous mass is more than sufficient to replace the loss of heat which replaced the shrinkage. In the case of a solid or liquid mass this is not so. The shrinkage of such a mass contracting under its own gravity on account of the loss of heat is never sufficient to make good the loss, but the temperature falls and the body cools."

Of the future duration of the sun Professor Young says: † "If this shrinkage theory of the solar heat is correct (and there is every reason to accept it) it follows that in time the sun's heat must come to an end, and looking backwards, we see that there must have been a beginning.

"We have not sufficient data to enable us to calculate the future duration of the sun with exactness, though an approximate estimate can be made. According to Newcomb, if the sun maintains its present radiation, it will have shrunk to half its present daimeter in about 5,000,000 years at the longest. Since, when reduced to this size, it must be about eight times as dense as now, it can hardly then continue to be mainly gaseous, and its temperature must begin to fall. New-

* General Astronomy, p. 244.
† " " p. 245.

comb's conclusion, therefore, is that it is not likely that the sun can continue to give sufficient heat to support such life on the earth as we are now acquainted with, for 10,000,000 years from the present time."

It is supposed by many that nature is self-energizing, but is there any proof of this? Nay, is not all the proof to the contrary? By the conservation of energy it has been proven that energy, or work, is in every instance convertible into heat, and heat, if it could all be conserved, could again be converted into any one of the other forms of energy, without loss. The law of the conservation of energy is stated by J. Clerk Maxwell, as follows: "The total energy of any body or system of bodies is a quantity which can neither be increased nor diminished by any mutual action of those bodies, though it may be transformed into any one of the forms of which energy is susceptible."

Commenting on this law, Professor William Garnett says: * "Hence it follows that if a system be unaffected by any agent external to itself, the whole amount of energy possessed by it will be constant, and independent of the mutual actions of its parts. If work be done upon a system or energy communicated to it from without, the energy of the system will be increased by the equivalent of the work so done or by the

* Encyclopedia Britannica, Vol. VIII, p. 207.

energy so communicated; while if the system be allowed to do work upon external bodies or in any way to communicate energy to them, the energy of the system will be diminished by the equivalent of the work so done or energy so communicated."

Farther on the same author says: "Though we can convert the whole of the energy possessed by any mechanical system into heat, it is not in our power to perform the inverse operation, and to untilize the whole of the heat in doing mechanical work. Thus we see that the different forms of energy are not equally valuable for conversion into work. The energy of a system should be measured by the amount of work it can do under the most favorable conditions which can be imagined, though we are not necessarily capable of realizing them. The ratio of the portion of the energy of a system which can under given conditions be converted into work to the whole amount of energy present is called the *availability* of the energy. If a system be removed from all communication with anything outside of itself, the whole amount of energy possessed by it will remain the same, but will of its own accord tend to undergo such transformations as will diminish its availability; for since work is done only when energy undergoes transformation, every change which it is allowed to undergo of its own accord

deprives us of one opportunity of deriving useful work, that is, of converting a portion of the energy into the particular form we desire. This principle, known as the principle of the dissipation of energy, was first pointed out by Sir William Thomson in the *Philosophical Magazine* for April 1852, and was applied by him to some of the principal problems of cosmical physics."

Thus energy, whilst it cannot be destroyed, when left to itself, dissipates, by radiation, and is lost to the system in which it originated and measurably to all other systems. As shown by Professor Garnett, though we attempt to conserve the heat developed in any mechanical system and turn it into some other form of energy, or work, we cannot get as much work from it as was required to produce the heat, because it dissipates into the surrounding matter.

Again our solar system is a striking example of heat dissipation and the loss of available energy thereby. Professor Young, writing on the assumption that the sun radiates heat equally in all directions, says: * "*So far as we can see*, only a minute fraction of the whole radiation ever reaches a resting-place. The earth receives about 1/2,200,000,000 of the whole, and the other planets of the solar system, with the comets and the meteors, get also their shares; all of them together, perhaps ten or twenty times as much as the earth.

* General Astronomy, p. 240.

Something like 1/100,000,000 of the whole seems to be utilized within the limits of the solar system. As for the rest science cannot tell what becomes of it. A part, of course, reaches distant stars and other objects in interstellar space, but by far the larger portion seems to be 'wasted,' according to our human ideas of waste."

Heat radiation, a repellent kinetic force, and gravitation, an attractive potential force, both strive to establish a normal tension and equal potential throughout the matter of the solar system as relates to its different parts and also to the regions outside the sun's magnetic field. The heat, therefore, of the solar system which is not utilized in the system and which escapes into space is converted into unavailable potential energy in the sea of æther in inter-stellar space; and the dense matter in the physical systems, by the process of cooling, also becomes unavailable potential energy.

The question whether the sun's heat is inherent and perpe ual or not, being one of much importance to the subject now under consideration we will quote from another author in order that the testimony may be made as strong as possible. Sir R.S. Ball says: * "The truth about the sun's heat appears to be that the sun is really an incandescent body losing heat, but that the operation of cooling is immensely retarded owing to a curious

* Encyclopedia Britannica Vol. XVII, p. 311.

circumstance due jointly to the stupendous mass of the sun and a remarkable law of heat. It is of course well known that if energy disappears in one form it reappears in another, and this principle applied to the sun will explain the famous difficulty.

"As the sun loses heat it contracts, and every pair of particles in the sun are nearer to each other after the contraction than they were before. The energy due to their separation is thus less in the contracted state than in the original state, and as that energy cannot be lost it must reappear in heat. The sun is thus slowly contracting; but as it contracts it gains heat by the operation of the law just referred to and thus the further cooling and further contraction of the sun is protracted until the additional heat obtained is radiated away. In this way we can reconcile the fact that the sun is certainly losing heat with the fact that the change in temperature has not been large enough to be perceived in historic times."

The evidence shows that the sun like other systems was made, that the energy imparted to it at the time of its formation is being dissipated and that it is slowly dying because the original source of energy is no longer available.

An examination of the physical forces in the earth also shows that none of them are spontaneous and continuous. From among them let

us take first the atmospheric circulation. The air is perfectly impotent to move itself. It is only when the energy embraced in the sun's rays strikes the earth that there is any circulation. The blasts of winter and the gentle breezes of summer are alike generated by the sun's heat.

Next, we observe the earth's water supply. During the rainy seasons of the year the inland lakes and rivers are full of water, but it persists in hastening on towards the great sea, and by and by the rains cease for a time and the fountains of water dry up. If for many months in succession no rain should fall the whole face of the dry land would become parched and barren. The great deserts of Africa and Asia are specimens of what would exist over the whole land of the globe. All the water having sunken deep into the bowels of the earth or run down into the sea, it is perfectly impotent to return and water the desolate earth, because water cannot act of its own initiative. Water, like other matter, can move or act only by the aid of some other agency. Again the moving agency is the sun's heat. Water is raised to a higher potential—level—by evaporation. The water belonging to the earth is not all in liquid form on the earth; some of it is in the form of vapor in the atmosphere.

It was said by Dalton, "That the vapor of water exists at all temperatures in the atmosphere, and is capable of bearing any known degree of cold without a total condensation." When the air is just full so that it will contain no more water it is said to be saturated. If saturated air is condensed by cold, clouds are formed and it rains, but if saturated air be expanded by heat a partial vapor vacuum is formed in the atmosphere. At such times "the pressure of its vapor is less than that to which the liquid is exposed," and consequently evaporation takes place from the surface of the liquid. Because of the law of evaporation which is dependent wholly on the temperature of the atmosphere, and this in turn on the heat of the sun, the earth is watered copiously by clouds carried over the mountains and plains, and thereby rendered fruitful and beautiful. This also is in accord with the universal law of nature that every action of matter is due to the influence of some other body.

In the above respect the law of nature is the same throughout the universe. Everywhere, we see that in the physical realm friction and stress arising from mechanical action, eventually precipitate every system, whether of celestial bodies, growing plants or animal life, into a state into which the unavailable potential forces

exceed the kinetic; the couple necessary to existence as a centre of energy, or as an individual possessing life, is broken and the system fails. The preponderating tendency or principle in nature is towards a uniformity of stress throughout the material universe, and just in proportion as this is realized inactivity results, and the power to do work is lost. The celestial systems are each a part of one great whole. They all radiate heat into what may properly be termed one infinitely large area, in which they themselves are situated. As their combined energy tends towards a uniform and unavailing potentiality there is a demand, from the standpoint of a continuance of the physical systems, for a universal kinetic energy which is in its nature self-acting.

Moreover the kinetic energy of all physical systems being a potentiality of some antecedent kinetic energy creation itself makes necessary a self-acting creative power.

The earth is an aggregation of matter, the product of many combinations of a few elementary bodies. * "The solid earth is mainly composed of substances such as quartz or silica, chalk or limestone, and various silicates like felspar and clay,—the elements which are the chief constituents of these substances being oxygen, silicon, carbon, calcium, magnesium, aluminium, iron and potassium." The atmosphere

* Encyclopedia Britannica, Vol. V, p. 467.

consists chiefly of two elements, oxygen and nitrogen, while water is composed entirely of oxygen and hydrogen. The plants consist mainly of carbon, hydrogen and oxygen, and animals consist of those three elements together with nitrogen. Ths eun and the stars are aggregations of compounds similar to those present in the earth, or of the elementary molecules which form those compounds. Therefore the molecules are not creations of the sun, nor of the earth, but the physical systems are formations of the molecules. Prof. J. C. Maxwell says, * "The formations of the molecules is an event not belonging to that order of nature under which we live. It is an operation of a kind which is not, so far as we are aware, going on on earth or in the sun or the stars, either now or since these bodies began to be formed."

While the formation of molecules must be referred to an epoch previous to that of the beginning of the solar system there is considerable phenomena indicating that these bodies, whose creation was anterior to the existing order of nature, are themselves compounds of smaller particles of matter, whose beginning antedates that of the molecules. The kinds of these early formed particles must consequently be much fewer than those of the larger molecules which are their compounds, just as the different kinds of molecules

* Encyclopedia Britannica, Vol. III, p. 49.

are fewer than their compounds. Thus all the available data lead us to the conclusion that all forms of matter are, like the earth, products of an antecedent molecule, particle or atom. Chemical action demonstrates that the molecular compounds are formed under certain conditions of heat. The principal characteristic of heat as an energy is its wave motion. The heat waves are therefore the principal agents in chemical action. These waves are a kinetic force. A product of this kinetic force is one and another compound form of matter, aggregations of which constitute the present order of nature. If nature is thus a product it is also a potentiality ; and as every potentiality has somewhere an antecedent kinetic energy the universe as a whole must have a self-acting eternal power to originate and maintain it.

As stated in the first chapter of this book our minds cannot reason about matter having been created from nothing because there is no data to support such a conception, neither is there anything demanding it. Physical laws show that energy is eternal though matter is not so. Our capacity to comprehend eternal energy may be circumscribed, but as all known phenomena demand such a power it remains for us to ascertain if there is sufficient data in nature to enable us to mentally grasp the conception of a self-existent, self-acting energy as an evident

fact. A phenomenon which throws much light upon this subject is that of living organisms. Matter, as such, is purely mechanical. In its organization it embodies a certain amount of mechanical energy but is wholly lacks self-action. It is, in its nature, a conductor of energy and not a self-acting, volitional, constructive energy. But matter constituted into living organisms is constructive, sentient, and volitional. In addition to its mechanical constitution, as living organism it possesses the power of action. Now what physical phenomena have we to show where this life comes from? For the answer let us turn to matter as a conductor of energy. The sun conducts to our earth radiations in the form of heat, light and electricity. We cannot see of what materials the sun is composed, but scientists confidently tell us that they know. Not only do they know what kind of molecules exist in the sun but they tell us also what kind of matter exists in the stars billions of miles distant. How? By the fact that the intervening æther conducts waves of light from those distant regions so accurately that astronomers know whether the waves are produced by this or that kind of molecule, action similar to terrestrial phenomena with which they are familiar. Scientists say also that the interplanetary space whilst transmitting the heat and light waves does not become warm and light, that the energy is

only conducted through the æther without being retained to any considerable extent. The æther is capable of thus conducting at least three primary forms of energy —light, heat and electromagnetism —and also multitudinous degrees of each of these forms of energy. These forms of energy, as to origin, must all be referred back to an unknown, self-acting, kinetic force. This kinetic energy, following the law of physical analogy, is a force opposed to matter, a force superior to matter, and a force which works in matter. This principle has already been pretty fully demonstrated. The cyclone is opposed to the anti-cyclone, yet the energy of the cyclone controls and works in the anti-cyclone. Positive electricity is opposed to negative electricity, yet the energy of the former is the source of the latter. Electromagnetic action in the magnet is opposed to the magnetic field, yet the former is the kinetic energy which governs the latter, and which works in the field as its potentiality. Heat is diametrically opposed to gravitation, yet heat is the kinetic force of gravitation, the latter being its potentiality.

What shall we say is the kinetic energy, the opposite, of the passive, physical universe? There can be but one answer. In all the realm of human knowledge and experience there is but one phenomenon which can be made an answer. It is

life-energy. Moreover, as æther is the universal medium of physical energy, so spirit is the medium of life. Of all physical energy æther is the nearest approach to spirit, both in the order of its creation and in its powers of action. The grosser forms of matter constituted of the primitive more tenuous forms, as in our solar system, are farthest removed from spirit, but as the cycle of spiritual and physical energy in matter progresses we ought to see a gradual nearer approach to the living kinetic energy of the whole system. That is just what we do find,—life appearing in matter, a potentiality of spirit. It appears also in the order in which we should expect to find it—the lower forms first, emerging from out the physical world and progressing towards higher forms until man, the most spiritual is reached. He, in his spiritual nature, approaches very nearly to the Great Spiritual Life of the whole universe. No more surely does the compass needle incline towards the north pole than does the moral and spiritual nature of man respond to the influences of the Spirit of God, his Maker.

Chapter XV

An Anti-Deistic Evolution Inadequate

Science has not yet found any method by which creation could have been originated and maintained without some agent acting as creator. The philosophic speculations enunciated in the principles of evolution as expounded by Darwin, Huxley, and Spencer do not rest on a firm scientific principle. They are built on the assumption that inorganic and organic matter, and mental and social phenomena are the work of evolution without the intervention of Deity. Professors Huxley and Sully define the general meaning of evolution thus:

* "Evolution includes all theories respecting the origin and order of the world which regard the higher and more complex forms of existence as following and depending on the lower and similar forms, which represent the course of the world as a gradual transition from the indeterminate to the determinate, from the uniform to the varied, and which assume the cause of this process to be immanent in the world itself that is thus transformed. All theories of evolution, properly so called, regard the physical world as a gradual progress from the simple to the complex, look upon the development of organic life as conditioned by that of the inorganic

* Enc. Brit. Vol. VIII, p. 751.

world, and view the course of mental life both of the individual and the race as correlated with a material process. This definition covers roughly the principal historical systems bearing the name of evolution, as well as others which have hardly as yet been characterized by this title."

Referring to evolution, creation, and emanation, by way of contrasting the idea of creation by Deity with the doctrine of creation by evolution the same authors say: "In seeking to answer these questions, the hypothesis of an evolution of the cosmos with all that it contains competes, in part at least, with two other principal doctrines respecting the origin of the world. These are the theory of direct creation by a personal Deity and that of emanation.

"It is clear that the doctrine of evolution is directly antagonistic to that of creation. Just as the biological doctrine of the transmutation of species is opposed to that of special creations, so the idea of evolution as applied to the formation of the world as a whole, is opposed to that of a direct creative volition. It substitutes within the ground which it covers the idea of a natural and necessary process for that of an arbitrary process. The question how far the doctrine of evolution, in its most extended and elaborate form, absolutely excludes the idea

of creative activity need not be dwelt on here. It is sufficient to say that the theory of evolution, by assuming an intelligent and adequate principle of change, simply illiminates the notion of creation from those regions of existence to which it is applied,"

Further on in the same article Huxley and Sully say of Herbert Spencer and his philosophy of evolution: "The thinker who has done more than any one else to elaborate a consistent philosophy of evolution on a scientific basis is Mr. Herbert Spencer. First of all he seeks to give greater precision to the conception of this universal process. Evolution is a change from the homogeneous to the heterogeneous, from the indefinite or undetermined to the defininte or determined, from the incoherent to the coherent. Again, Mr. Spencer seeks to show that the causes of evolution are involved in the ultimate laws of matter, force, and motion, among which he gives great prominence to the modern doctrine of conservation of energy. Thus the rationale of the process shapes itself to Mr. Spencer as a distinctly mechanical problem. He set out with the assumption of a limited homogeneous matter acted upon by the incident forces, and seeks to show how, by the help of two laws,—namely, the instability of the homogeneous, and the multiplication of the

effects of any such incident force the process known as evolution is brought about. This process is illustrated in the genesis of the solar system, for the illustration of which Mr. Spencer makes use of the nebular hypothesis, in the formation of our planet, as well as the development of the organic and mental life. Mr. Spencer does not, however, conceive of this process as unlimited in time. As in the development of the individual organism, so in that of organic beings as a whole, of the earth, and of the solar system, there is a conflict between the forces of which the action is integrating or consolidating and those of which the action is disintegrating. The process of evolution always tends to an equilibration between these conflicting forces and ultimately to a dissolution of the products of evolution. Thus the solar system is a moving equilibrium which is destined to be finally dissipated into the attenuated matter out of which it arose. Mr. Spencer thus approaches the earliest theories of cosmic evolution when he tells us that vast periods in which the forces of attraction prevail over those of repulsion, alternate with other vast periods in which the reverse relation holds. The mechanical theory of evolution thus laid down in the *First Principles* is applied in Mr. Syencer's later works to the explanation of organic, mental and social

evolution. The full explanation of the processes of inorganic evolution finds no place in the writer's system. Mr. Spencer seeks, in the *Principles of Biology*, to conceive of organic bodies, and their actions in mechanical terms. Life is regarded as essentially a correspondence of internal actions in the organism to external actions proceeding from the environment, and the object of Mr. Spencer's volumes is to explain on mechanical principles the growth of this correspondence from the lowest to the highest. He excludes all consideration of the question how life arose, though it is clear that he regards the lowest forms of life as continuous in their essential nature with sub-vital processes. It is in the later volumes, dealing with mental and social evolution, that Mr. Spencer's exposition becomes most interesting to the student of philosophy. In the *Principles of Psychology*, he seeks to deal with mind as an aspect or correlate of life which begins to manifest itself when the process of adjustment to environment, in which all life consists, reaches a certain degree of complexity."

In concluding that part of their article referring to Mr. Spencer the writers say: "So far we have said nothing respecting the metaphysical basis which Mr. Spencer seeks to give to his doctrine of evolution itself. Mr. Spencer is a thorough-going

realist. From his general scheme of evolution one would be prepared to find him avowing himself a materialist. Yet he seeks to avoid this conclusion by saying that it is one unknowable reality which manifests itself alike in the material and in the mental domain. At the same time this unknowable is commonly spoken of as force, and in many places seems to be identified with material force. Mr. Spencer makes little use of his metaphysical conception in accounting for the evolution of things. He tells us neither why the unknowable should manifest itself in time at all, nor why it should appear as a material world before it appears under the form of mind or consciousness. Indeed Mr. Spencer's doctrine of evolution cannot be said to have received from its author an adequate metaphysical interpretation. The idea of the unknowable hardly suffices to give to his system an intelligible monistic basis. In truth, this system seems in its essence to be dualistic rather than monistic."

A brief summary of what evolution does not do, as enumerated by its authors, shows that it fails in not accounting for cosmic creation ; it excludes the consideration of the subject of how life began ; it has nothing to say about the co-existence of sentience with matter ; and in both the realms of the material and mental all is a vast unknowable. These principles all lie at the very foundation of

an adequate reason for the existence of all things. How, then, can it be said that evolution is able to dispense with an intelligent creator?

In the definition which the authors give of evolution they tell us that it includes all theories which regard the process going on in the world, from the uniform to the varied, as being "immanent in the world itself." They tell us also that "the doctrine of evolution is directly antagonistic to that of creation." A few decades ago Prof. Tyndall and other evolutionists said, "We see in matter the promise and potency of every form of life." But through experimentation, in which, during a period of years, life failed to evolve in a solution of vegetable matter which had been exposed to a high temperature and hermetically sealed they were forced from their former position and compelled to say, "We have no scientific data for saying that life can come from anything less than life." Hence the adequate cause for life which the evolutionists thought they had found to be "immanent in the world itself" failed, and the need for a Creator has again become imperative.

Sir Isaac Newton's Third Law of Motion bears an important relation to this subject. It says, "To every action there is alway san equal and contrary reaction; or the mutual actions of any two bodies are always equal and oppositely directed. This law shows that reaction never exceeds action. A

stream of water can never rise higher than its source.

A scientific view of creation comprehends that tenuous matter—æther, and molecules—existed before the sun systems. Each atom and molecule, being a system like unto the electromagnetic sun systems, must have been created in a manner similar to the method employed in the creation of those systems. If æther existed before all forms of denser matter and filled the immensity of space as it does now there must have been a power back of each atom exercising a force upon it equal to the dual energy possessed by it; also, it is evident from the laws of mechanics that the total power expended on the whole number of the ætherial atoms must have been equal to the combined energies of the whole of the ætherial sea of the universe. Thus both from the electromagnetic constitution of matter and from the laws of dynamics it is evident that matter possesses energy by induction only. Its energy is not its own. It is a conservatory of energy by virtue of its constitutional potentiality. A system grows because more energy is imparted to it. It declines or disintegrates because the energy conserved in it dissipates. Whilst matter can be dissolved we have seen that energy cannot be destroyed. Matter is changeable and finite. Energy is infinite. A knowledge of the nature of energy

forbids our thinking that it exists in a vacuum, or apart from substance. Here then we get a glimpse into the infinite past when the worlds were unformed. Resolve all matter, even the most tenuous, into its primary substance. Change all created beings on earth and in heaven back, through a reversal of the processes of creation, to the time when the fiat went forth that they should be created, and Spirit, possessing mind-life, will remain. The only spiritual energy known to us is connected with mind. It is the only force in nature superior to unintelligent matter, and the only one possessing initiative energy.

Prof. Jay G. Rodger says,* "The scientist has been driven to the conclusion that life is not the function of organism, but the builder of organism.

"He has been compelled to admit that life is a worker, a builder, and instead of the organism preceding life, life builds the organism, and consequently precedes it. Life-energy organized the vegetable elements in the sand into a living organism. Each grade of life-energy built an organism suited to its kind, when the lower organism had furnished materials from which to build. And this life-energy is God, the Universal Father, working directly through secondary causes. This constitutes the principle of *involution*, as opposed to the popular original idea of evolution, viz: that life is spontaneously generated from

* Syllabus of Ten Lectures, Japan, 1909.

matter, and that lower forms of life *naturally* develop into higher forms."

In view of all the phenomena opposed to an anti-Deistic, materialistic evolution it must be maintained that evolution of that kind fails to meet the requirements either of physical science or of psychic phenomena.

Chapter XVI

The Image of the Invisible

Mankind, since the beginning of the human race, has sought, each in his own manner, to delve into the depths of the invisible in search of the origin of the visible creation, but no one has yet attained to a complete knowledge. Any philosophical basis which hopes to satisfy the human consciousness must approach the subject from the positions both of science and religion, the basis embodying the essentials of the two elements. Neither the desire for scientific knowledge nor the thirst of the soul for a spiritual foundation upon which to anchor the cravings of the heart after eternal realities can ever be eradicated from the mind of man. Consequently it is in the desire to know, not only the material but the spiritual also, that we can hope to solve the problem of life.

Science, apart from metaphysics, has not found a satisfactory reason for the beginning or the end of the physical systems. Professor Young aptly expresses the uncertainty which scientific men are in, as follows: "If we carry our imagination backwards we reach at last a 'beginning of things,' which has no intelligible antecedent; if forward, an end of things in stagnation."

With reference to the difficulty of accounting for metaphysical phenomena on the basis of a material evolution, Huxley says: "If materialism recommends itself by assuming the fewest possible principles, it is exposed to the objection that it bids us conceive a reality which is wholly distinct from mind. Further, it fails to give any intelligible account of the rise and progress of mental activity."

Whilst science has been, and ever will be, unable to find a solution of the genesis of things when reasoning solely from the old standpoint of the centripetal and the centrifugal forces, or from the modern view of a Godless material evolution, it is nevertheless true that if the subject be studied from the basis of the electromagnetic constitution of all matter, and gravitation be understood as arising from unequal pressure upon matter due to a reactionary effect of heat radiation in which unequal density, and inertia, bear a prominent part, an understanding of creation, and of mental and spiritual phenomena, becomes more nearly realizable.

In the preceding chapter reference was made to Newton's law of motion that reaction is equal to action, but in an opposite direction, thus establishing the principle that physical action is a reflex energy. Upon this principle depends the phenomenon so clearly established

that all energy moves in cycles. The cyclone, the electromagnet, heat and gravitation, are only a few examples of the working of the principle of energy moving in cycles. The energy in the transmission from one part of a cycle to another may change its form; but, eventually the primary or kinetic form of the energy will again assert itself. An illustration of this is seen in gravitation. As a potentiality of heat radiation it not only acts in opposition to radiation but seems an altogether different form of energy, yet gravitation in a falling body, by the impact of the body with the earth is again converted into radiant heat through the molecular motion it engenders in the body and in the earth in contact with it.

Living organisms also undergo cyclical changes. Prof. Huxley says: * "In the ordinary course of nature, all living matter proceeds from pre-existing living matter, a portion of the latter being detached and acquiring an independent existence. The new form takes on the characters of that from which it arose; exhibits the same power of propagating itself by means of an offshoot; and, sooner or later, like its predecessor, ceases to live, and is resolved into more highly oxidated compounds of its elements."

Therefore, in the principle of the equality of action and reaction, moving in opposite directions,

* Enc. Brit., Vol. III, p. 679.

there is established the principle of the cycle, and also the principle that like produces like. Sound waves produce sound waves. Heat waves produce heat waves. Light produces light. So true is this that stars billions of miles distant reflect upon the earth each its own peculiar light, to the extent that the kinds of gases in the photosphere of each star can be detected. Electrical action produces electrical action. Anger begets anger. Love begets love. Hate begets hate. In the vegetable and the animal kingdoms each individual produces its own kind. Throughout the entire universe, one law governs all, whether it be in the inorganic, vegetable or animal, the mechanical, mental or spiritual domain, like energy begets like energy.

Now in accordance with the above law, by referring the four primary phenomena visible in creation, namely, the dualistic, functional, mental, and spiritual, to their primary source it is easy enough to know not only the existence of Deity but also the principal attributes of His Being.

First, the Dualistic Attribute. This attribute finds its exemplification in the electromagnetic constitution of matter and the dual energies therein manifest, and in all physical systems of the mineral, the vegetable, and the animal kingdoms. Electromagnetic duality exists everywhere in the solar system as now constituted.

Moreover, under the influence of sufficient heat the solar system, with its great nucleus and greater magnetic field, with its planets and satellites, could be dissolved and expelled into space. As gases, these molecules, with their respective dual parts could likewise be resolved into their smaller elements. This dissolution of matter can be theoretically carried back until there seems to be no end to the divisibilty of matter; but regardless of how far back we go matter still retains its dual characteristics, which belong to an electromagnetic nucleus and its field. There must be a point somewhere in the infinite past where substance is no longer divisible into atoms, but scientists tell us that here necessity exists for a perfect fluid, or plenum. This brings us to the closing paragraphs of the preceding chapter where it was shown that back of the cosmos lies the entire creative power of the physical universe. Therefore by observing the law that like begets like we are logically led to believe that antecedent to matter there is creative Spirit and that one characteristic of the creative power is dualism. If creation is a potentiality, a reflex energy of a spiritual kinetic energy proceeding from Deity, then duality, the foundation principle of energy throughout creation, must be a conseqence of duality in the Creator. Moreover, if duality in both the

physical and the spiritual realms be accepted it not only becomes apparent that matter, somehow, emenates from Spirit, but also that matter merges into spirit.* If that is true the smallest particle of matter is enveloped in a spiritual environment which is a part of the Great Spirit, the quickening energy of which is from Deity. Therefore, His Spirit is immanent in creation, everywhere, and all matter, visible and invisible, in its constitution partakes in a measure of the image of the Creator.

When the light shines and we see an object it is not the object itself which we see but only a reflection of it. We never really see any objects but only images of objects. So in nature we see not God but images of his personality, not pictures, but forms of energy producing individuality and personality in matter like unto His divine spiritual personality. The first of the images which we see in nature, reaching back to the Great Spirit from whence it came, is duality in unity.

What has already been said of duality, as seen in the inorganic world, may be termed mere mechanical duality, but in the case of living organisms it is not wholly mechanical. This fact accentuates our conclusion that duality in creation proceeds from a dual spiritual Being. Huxley says; † "Living things are not only

* The resurrection and ascension of Christ, and also the Christian doctrine of the general resurrection, accord with this view.

† Enc. Brit. Vol. III, p 684.

natural bodies having a definite form and mode of structure, growth, and development. They are machines in action; and, under this aspect, the phenomena which they present have no parallel in the mineral world."

All living bodies, both plants and animals, are composed of protoplasm. This substance, so far as known, exists nowhere outside of living bodies. It is a product of secretion, both of the vegetable and the animal world. Physiologists at one time thought that life was the result of the structural organization of protoplasm into cells, but more complete investigation showed that in some low forms of life the cellular organization, so far as the microscope could reveal, was lacking. Then, *"It was no longer possible to refer the physiological phenomena of the cell to its organization; it became evident that the work done by a 'cell' was the result not of its form and cellular structure but simply of the nature and properties of the apparently structureless protoplasm which formed its body. A new idea passed itself on men's minds, that organization was a concomitant and result of vital action, not its condition and cause; as Huxley in one of his earliest writings put it, 'They (cells) are no more the producers of the vital phenomena than the shells scattered in orderly lines along the sea-beach are the instruments by which the gravitative

*Enc. Brit. Vol. XIX, p. 12.

force of the moon acts upon the ocean. Like these the cells mark only where the vital tides have been, and how they have acted'." From this it is evident that the life phenomena manifest in protoplasm is related to its molecular constitution, and also, what is more important, that the molecules themselves are a product of a creative energy which preceded their formation.

A remarkable phenomenon of protoplasm is its metabolic duality—action* "consisting on the one hand of a downward series of changes (Katabolic changes), a stair of many steps, in which more complex bodies are broken down with the setting free of energy into simpler and simpler waste bodies, and on the other hand of an upward series of changes (Anabolic changes), also a stair of many steps, by which the dead food, of varying simplicity or complexity, is, with the further assumption of energy, built up into more and more complex bodies. The summit of this double stair we call 'protoplasm.' Whether we have a right to speak of it as a single body, in the chemical sense of that word, or as a mixture in some way of several bodies, whether we should regard it as the very summit of the double stair, or as embracing as well the topmost steps on either side, we cannot at present tell."

The processes constantly taking place in living bodies clearly show that the protoplasmic

* Prof. Foster, Enc. Brit. Vol. XIX, p. 13.

molecules themselves are living particles possessing powers of *assimilation*, i. e., of building up the dead food into its living self; of movement, or of *contraciltiy* as it is called, i. e., of changing its form through internal explosive changes; and of *irratability* or *sensitiveness*, i. e., of responding to external changes, by less massive internal explosions which, spreading through its mass, are not in themselves recognizable through visible changes, though they may initiate the larger visible changes of movement. These and other fundamental series of chemical changes, of constructive and destructive metabolism, are present in protoplasm wherever found." Thus the summit of the chemical changes in the constructive and destructive processes of each molecule of protoplasm seems to be a sort of living nucleus or centre of action, because each one holds within itself all the forces, potentially at least, of constructive and destructive metabolism manifested in larger living bodies composed of aggregates of these molecules.

Speaking broadly it may be confidently affirmed that the protoplasmic molecules themselves are minute living bodies, each a living nucleus possessing duality of life, just as the ætherial atoms are centers of electromagnetic force. Consequently in all living bodies both kinetic and potential phenomena, constituting duality, are present.

We find therefore that the principle of duality involving cycles of energy, the kinetic centre of which is located somewhere within each system, is everywhere present in the mineral, the vegetable, and the animal kingdoms. It is everywhere duality in unity, a principle traceable back to the Creator of the universe.

Second, the Functional Attribute. Only living bodies have functions. Physical living beings are not only natural bodies possessing duality, but each has a definite form and mode of organic structure, growth, and development. The actions of living bodies are termed their functions. These functions are primarily those which affect the material composition of the body; those which subserve the process of reproduction; and those in virtue of which one part of the body is able to exert a direct influence on another part, and the body, by its parts or as a whole, becomes a source of motion. Functions are involved in the constitutional organization and in all mental phenomena.

Contrasting the organic world with the mineral, Huxley says, "The biological sciences are sharply marked off from the abiological, or those which treat of the phenomena manifested by not-living matter, in so far as the properties of living matter distinguish it absolutely from all other kinds of things, and as the present state of

knowledge furnishes us with no link between the living and the not-living." The infusion of life into matter previously dead has sometimes been called the "Unknown Increment," because of the inability of science to show from whence life came. Living matter possesses all the characteristics of physical constitution possessed by dead matter, and in addition it has the characteristics of life, not in one form only but in ever varying and more complex forms until man, the highest, is reached.

What science knows of the beginning of life is that the primary and fundamental form of it is merely an individual mass of protoplasm called a cell, in which no further structure is discernible. This is the morphological unit of life. All the higher forms of life are aggregates of such morphological units or cells, variously modified. No exception is known to the general law, established upon an immense number of observations, that every living thing has its beginning in such a particle of matter. All life is a product of parentage. Its multiplication is performed in various ways, but it is invariably by an evolution from the substance of the parent cell and not by the addition of some physical exterior product. All germ-cells, whether of plant or animal, consist each of a mass of protoplasm enclosing somewhere within itself a visible nucleus. This nucleus is the kinetic or living

energy of the cell, while the larger and remaining part of the cell is its potential field, as it were.

Prof. Huxley says, "The definition of a germ as 'matter potentially alive, and having within itself the tendency to assume a definite living form' appears to meet all the requirements of modern science. For notwithstanding it might be justly questioned whether a germ is not merely potentially, but rather actually, alive, though its vital manifestations are reduced to a minimum the term 'potential' may fairly be used in a sense, broad enough to escape the objection."

So far as at present known the germ-life, its potentiality, its functions, are all inherited. They are hereditary. The great characteristic of the germ is not so much what it is, but what it may, under suitable conditions, become.

The duality of the mineral world, with its nucleus of energy and its field, and its cycle, becomes, in the world of life, functional organism. The plant is composed of aggregates of cells all of which are centres of energy in the plant, and almost all of these cells show, under the microscope, their two distinct divisions of nucleus and field. The plant, as a developed product, whilst being an aggregation of these cells is also a system of energy as a whole, the stem or trunk being a kind of centre of energy for its circulatory and

kinetic system, while the roots on one side and the branches on the other are the potentiality of the system. They are the functional organs which supply the food and carry off the waste material.

If we turn to the animal organism we find there also the centre of energy principle operative in a very comlex form. The individual animal is a single centre of energy, but of what a multitude of different sub-centres it is constituted, each dependent in a greater or lesser degree upon the others! The circulatory system, centred in the heart, with its two sets of blood vessels, one to carry the blood away from the heart and the other to bring it back; the digestive system, with its two sets of organs, one leading to the stomach and the other away from it; the respiratory system, centreing in a pair of lungs, all the organs of which perform a dual service; and the nervous system, centred in the brain, with its dual sets of nerves ramifying the entire body, each couple performing their peculiar functions, whether of touch, taste, sight, smelling, or hearing. In all these sub-systems of vital energy one half of the duality is objective or active and the other subjective or passive, and all combine to form a single organism. The brain is the centre, the seat of the kinetic energy, while the nervous system is the field. Thus the duality manifests

itself in functional organs and functional activities. Therefore, in the various and complex forms of matter present in living beings one law exists in multitudinous forms. The more complex the system becomes in the functional application of this single law the higher the physical mechanism becomes, as witnessed in the mechanical constitution of man. Now, if the attribute of dualism is a principle inherited from the divine Being so is the functional attribute of all living organisms. This does not imply that God is constituted of flesh and blood nor that He is physical in any sense, but that He is constituted of spiritual substance and that in His infinite personality certain parts have functional uses which enable Him to preserve His individuality, and to perform whatever He wills to do. It is in accordance with the order of the universe, therefore, that as God possesses functional attributes and is immanent in nature the phenomena of functional energy should become manifest in nature as the higher forms of organization are attained to. As this truth becomes apparent the "Unknown Increment" of science becomes the "Known Increment" of Spirit, God evolving new forms of life by involutions of His own Spirit and maintaining them by His own Energy.

Third, the Mental Attribute. In our brief consideration of mental phenomena it will be

impossible to enter far into psychology as a natural science, or into metaphysical deductions, but I shall endeavor to set up a few milestones which will lead easily from psychological data to a solid metaphysical basis.

Prof. William James, Harvard University, says, *" The immediate condition of a state of consciousness is an activity of some sort in the cerebral hemispheres. This proposition is supported by so many pathological facts, and laid by physiologists at the base of so many of their reasonings, that to the medically educated mind it seems almost axiomatic." Prof. James further says, " This conception is the ' working hypothesis ' which underlies all the ' physiological psychology' of recent years." However, he qualifies this seeming *a priori* materialism by saying, " In one sense it doubtless is materialism : it puts the Higher at the mercy of the Lower. But although we affirm that the *coming to pass* of thought is a consequence of mechanical laws,—for, according to another ' working hypothesis; ' that namely of physiology, the laws of brain-action are at bottom mechanical laws,—we do not in the least explain the nature of thought by affirming this dependence, and in that latter sense our proposition is not materialism. The authors who most unconditionally affirm the dependence of our thoughts on our brain to be a fact are often the

* Text Book of Psychology, pp. 5, 6.

loudest to insist that the fact is inexplicable, and that the intimate essence of consciousness can never be rationally accounted for by any material cause."

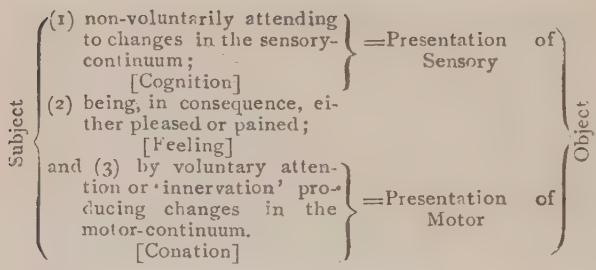
The individual conscious subject is but one being in a universe which stretches out behind him and before him apparently without any limit. Of the things by which he is surrounded he sees but a small part, and the influences which he receives from them, as he knows, are only a partial expression of impulses that come from regions beyond his knowledge. He finds himself as one in a changing series of beings of which he knows only the last preceding terms, and he is aware that he as one of that series, will soon cease to be. Thus, when he reflects upon himself, from this point of view he is forced to regard himself as but a fragment of an unknown whole by which his entire being has been determined to be what it is. The consciousness of the outside world stands in a singular relation to the consciousness of the individual within. It is only by coming to a better knowledge of ourselves that we can understand where those lines of energy which extend into the past of eternity, and those which are before us leading on to the unseen world, meet in a consummate knowledge of the whole.

The brain is an aggregate of nerve cells.

Leading to the brain from all parts of the body are sensory nerves whose function is to convey impressions made on the body by objects in the outer world; and, likewise, leading from the brain are motor nerves whose function is to carry energy to the muscles of the body capable of setting them in motion. The power of the brain which enables it to recognize impressions that come to it through the nerves, and by means of other nerves to react upon the outer world through muscular activity is, roughly speaking, called consciousness. In consciousness two things are always present—the thinker and the object of which he thinks. The phenomenon of thought or idea has its source in sub-conscious presentations which are continuous in the brain and which roll across the mind in a series of waves, each one of which at a certain moment of intensity becomes conscious thought by the attention becoming fixed upon it.

Prof. Ward, Cambridge University, summing up his general analysis of mind, says, *"Taking no account of the specific difference between one concrete state of mind and another and supposing that we are dealing with presentations in their simplest form; i.e., as sensations and movements, we have:—

* Encyclopedia Britannica, Vol. XX, p. 44.


Subject
(1) non-voluntarily attending to changes in the sensory-continuum; [Cognition]
(2) being, in consequence, either pleased or pained; [Feeling]
and (3) by voluntary attention or 'innervation' producing changes in the motor-continuum. [Conation]
=Presentation of Sensory
=Presentation of Motor
Object

"Of the three phases, thus logically distinguishable, the first and the third correspond in the main with the receptive and active states or powers of the older psychologists. The second phase, being more difficult to isolate, was long overlooked; or, at all events, its essential characteristics were not distinctly marked."

Prof. James says, "Incoming nerve-currents are the only agents which normally affect the brain." When these nerve-currents arise from contact with bodies outside the animal organism the whole animal body is the subject while the body causing the current is the object; but when a man thinks of his hand he says, "it is mine." When he thinks of his entire person he says, "It is me." In these latter instances the individual has become both the subject and the object in the action which we call consciousness. What is it then which is the I, the Ego, and what is it that is the Me? Can one thing be both the subject and the object at the same time? I am conscious

of my own existence. No knowledge is more certain to me than that which tells me of my existence. No sensation in particular is being presented to me, but I have a certain consciousness that I am. My limbs and considerable portions of my body might be removed and yet the I would remain. How much of me could be dispensed with and yet I be left? Physiologically speaking the brain and such parts of the nervous and nutritive systems as are necessary to life would have to be retained in order to preserve the Ego. Consciousness begins as a sub-conscious wave in a fibre which leads to the brain. At its maximum height in the brain it produces an idea. It then passes on as motor energy or as feeling of pleasure or pain. In answer to the question whether the I and the Me can both be the same in any sensation it must be said that they cannot. The same particle cannot be the subject of an action and the object of it in the same moment, because action and reaction are both involved, and wherever these occur in the same instant in any system energy always moves in opposite directions, thus rendering it impossible for the same particle to be both the subject and the object in any single action. But action and reaction may succeed each other so rapidly that one conscious presentation would not wholly disappear from the mind until

another had come. The slowest heat wave probably numbers billions per second. The action of the mind wave is slower but somewhat like the heat wave. It is quite probable also that the subject of a presentation and its object may be brought very near together in the brain. The sensory action and the motor reaction no doubt exist in the same molecule in the brain centres, similar to magnetic action in the magnet which involves molecular positive and negative energy. It was previously shown that the dual energy which maintains the life of animal organisms is molecular, that it travels up in the first instance, building up the protoplasm, and down, in the second instance, destroying it. Like the energy of the magnet the energy of the living cell moves in cycles, half being positive and half negative. So also, the nerve-current of consciousness moves through a brain cell in cycles, one half being subjective and the other half objective. It is possible that in a very small area at the brain centres one particle may be one moment subject and the next moment object.

A presentation in the brain causes a nervous discharge. Professor James says the word "discharge" is constantly used "to designate the escape of a current downwards into muscles or other internal organs. The reader must not understand the word figuratively. From the

point of view of dynamics the passage of a current out of a motor cell is probably altogether analogous to the explosion of a gun. The matter of the cell is in a state of internal tension, which the incoming current resolves, tumbling the molecules into a more stable equilibrium and liberating an amount of energy which starts the current of the outgoing fibre. This current is stronger than that of the incoming fibre."

Of the nature of nerve-currents Prof. Foster says, * "The intrinsic nature of the change in a nerve-fibre effected by a stimulus is quite unknown; but it is important to appreciate clearly the view that a nerve is both a receiver and a conductor of impressions. It can be stimulated in any part of its course, and from the stimulated point some kind of change is propagated along the nerve. This change is analogous to the passage of electricity along a conductor, or to the rapid passage onwards of a series of chemical decompositions. Whatever the change may be, however, it does not appear to pass from one nerve-fibre to another running along-side it. Each fibre conducts only its own impression, and there is nothing analogous to the inductive effect of one electrical conductor upon an adjacent one."

Now, what bearing have the physiological and psychological sciences upon the mental or the intellectual nature of man as tending to prove

* Enc. Brit., Vol. XIX, p. 26.

the existsnce of a mental attribute in a Creator, or, that the Ego in man is anything more than a phenomenon arising from physical organism? The material for the answer is to be found in the pages of this book. The phenomena of the physical universe,—heat, light, electro-magnetism, gravitation, chemical affinity in the mineral kingdom, the building up and tearing down of the cells of living bodies, the presentations to the brain of nervous sensations, and the nervous discharges from the brain, are all consummated by a wave energy in a medium, or in different media. If all known phenomena are in some manner products of wave energy what shall we say of phenomena which proceed from a source anterior to physical phenomena and whose source we do not so fully understand? The phenomena arising from ætherial action in the material world are but partially understood, yet how wonderful is that which we do know of the energy of æther! As the medium of heat, light, magnetism, its waves work in liquid and solid substances, producing in each kind of matter a different wave energy from that produced in any other body, each of which is known to us as a separate phenomenon, and called by a separate name. The only logical conclusion which we can come to is that beyond molecular matter, and beyond atomic æther, there is another substance, not matter,

whose energy produces phenomena in the world harmonizing with the characteristics of its own nature. This energy, in order to produce physical phenomena, must, we think, connect with matter by a form of undulatory energy suited to the constitution of physical substance, and, in order to produce mental and spiritual phenomena, it must embrace mental and spiritual characteristics which transcend the physical. In harmony with what seems to be a universal law it may be presumed that the Spirit, as the source of mental action, works in the mind as undulatory energy.

Science admits ignorance as to how life began in this world. It is equally silent as to how in physical life mind has been manifested. It is also quite as far from understanding the spiritual nature of man, the world over. But if we see in the physical the image of the unseen world we can understand. The psychological data then merge easily into the metaphysical. The undulatory energy of the unseen Spirit flows through the physical mechanism creating and maintaining life. It flows through the physical organism and gives mental powers to the individual. It flows through man's being and quickens his intellectual life into a spiritual personality able to apprehend his Maker.

The different bodies in the sun reproduce their original colors here on the earth through

ætherial wave energy. How logical and beautiful the thought that God reproduces in us, through the effulgence of the Spirit, the attributes of Himself,—life, mind, will, and spirituality. This scientific view of the origin of organic and mental phenomena seems to be corroborated by the Bible. In Genesis, 1 : 2, it says that when the earth was in process of creation, "The Spirit of God moved upon the face of the waters," and order was brought out of chaos. The same truth is also demonstrated in Acts, 2 : 2-4, in which it says, "And suddenly there came from heaven a sound as of the rushing of a mighty wind, and it filled all the house where they were sitting. And there appeared unto them tongues parting asunder, like as of fire; and it sat upon each one of them. And they were all filled with the Holy Spirit, and began to speak with other tongues, as the Spirit gave them utterance."

Fourth, the Spiritual Attribute. The high basis upon which we now stand has been reached rising from the mineral to the living, functional individual; from the functional to the mental, and from the mental to the Spiritual, first, by successive involutions from the Great Spirit, and, second, by continuous Spirit-currents flowing through and sustaining the created bodies and intelligences of the world. We have seen that

the dualistic principle in consequence of the centre of energy as a kinetic force, and its field as a consequence of the reactionary potential force, the two opposite forces forming a cycle of energy, extends from the atom and the molecule of inorganic matter up into the protoplasmic vegetable cell; and thence into the animal cell-life. It is equally present also in mental phenomena in the I and the Me of the individual,—in the subject as thinker and the object as being thought of. It is present also in the spiritual. If our conclusion that the Spirit-currents flowing from God reflect the intelligence of the Creator in the mind of the child of earth, like as a molecule of hydrogen in the sun reflects its own color on the earth, rests upon a solid foundation, then the spiritual energies of the soul of man are also a reflection, yea more, an image of the Great Spirit who lives in and through all. Therefore the narrow limits of our individual life cease to be for us the limits of a contracted circle of definition within a formless infinite. In the language of Prof. Caird, * "They become the limits of a sphere within a sp' ere, a sphere which is defined by the idea of knowledge or self-consciousness itself, and in which therefore, however we may wander, we are everywhere at home. In religious language, the sphere is not a mere universe, but God, who is

* Enc. Brit., Vol. XVI, p. 93.

without us only as He is within us, so that by the God within we can understand the God without."

The most momentous question which claims the attention of all men is whether if a man die he shall live again. If the vegetable dies no one suposes that it will live again. If the animal dies civilized people generally suppose that its spirit dies with it, or, at least, this is the supposition among Christian peoples. Now, if the life of the vegetable, and the life of the beast, and the life of man, are all from God, what basis is there, when all the other forms of life are subject to extinction, for believing that the life of man will continue after the death of the body? Chemistry, physiology and psychology, as natural sciences, can find no substance in the brain of man which is not found also in the brains of other animals. But psychology teaches one thing which will help us just at this point. Prof. James says, "The richer insight of modern days perceives that our inner faculties are adapted in advance to the features of the world in which we dwell, adapted, I mean, so as to secure our safety and prosperity in its midst.....Mind and world in short have been evolved together, and in consequence are something of a mutual fit."

"The chief result of all this more modern view is the gradually growing conviction that mental life is primarily teleological; that is to say, that

our various ways of feeling and thinking have grown to be what they are because of their utility in shaping our reactions on the outer world."

Here psychology makes the mental life of the individual to consist of certain ways of feeling and thinking, i.e., of knowledge, sensations. The nature of this knowledge is two-fold—subjective, passive; and objective, active. The subjective consists in presentations from the outer world, a means to an end. The objective consists in various reactions of the subject on the world, mostly of a self-preservative nature. In other language this means that a person's mental life is the result, on the one hand, of impressions produced upon him from the great world in which he lives, and, on the other hand, it is the result of the response on his part which those impressions arouse in him towards the outer world.

But if the mental life consists in a knowledge of actions which come from the world without and of reactions which proceed back to that world, what shall we say of the spiritual life? Does it also not consist in knowing? Knowing what? In knowing, being cognizant of, the spiritual presentations which come from the spiritual world without and of the reactionary, responsive effort which those presentations arouse in the soul. The mere animal does not become cognizant of

the spiritual presentations so as to apprehend God. He is without spiritual congnition, and consequently without a spirit life. The man who does become congnizant of the spiritual presentations has a spiritual soul whose life transcends the material, and which will not perish with the body. "O God, I think thy thoughts after thee," said Kepler. Psychology leads up to this point of view, and it is confirmed by Christ, in his words, "And this is life eternal, that they should know thee, the only true God, and him whom thou didst send, even Jesus Christ."

Huxley's statement that the cell of protoplasm is not the life, but an index only of how high the life-tides have risen is an expression of a wonderful truth. It corroborates what has been demonstrated time and again, that matter, however organized, is but a transmitter, an agent, of energy, not a source of energy. The ætherial atom represents a certain amount of derived energy; the molecule is composed of derived energy in the form of atoms constituted into a system. A world is a larger system of the same kind. A plant shows where the tide of life energy has risen higher. The plant is not the life but only an organism in which the life energy is manifested. And so on up through the animal organisms, each one is a nucleus in which the universal life energy is made manifest. The animal body

is not the life, but the organism which holds the universal life energy. The human brain is the organ of the mind, but it is not mind itself, only the organ of mind. The human mind, though having its seat in the brain, is not solely physical because it can receive and reciprocate impressions which come from the Infinite. It is not only a physical embodiment of life energy but also a spiritual personality. It is a child of the Infinite Mind reinforced by the experiences of a physical life. It is capable not only of physical presentations and reactions, but of spiritual presentations and responses which do not come and go directly through any of the five senses of the body. And the mind which comes into spiritual relation with God is a spiritual being who knows God and who is known of God as His child. Such a person has a mind-nucleus with a field whose potentiality extends to the Infinite Father in heaven.

It matters not that when the body falls to dust we lose the power of consciousness through the physical senses; we live because the eternal life is in us and we are in Him. For many years, while my dear mother was alive, though we were separated by thousands of miles, I lived in her mental vision. My form, my words, my acts, my character all constituted an ineffaceable image in her mind. The same was true of her as living in my own mind. We lived in each other. Her

death has not effaced that life of hers in me. Nothing can efface it while my memory lasts. So Christ and the Christian live in each other. Though my body die I shall continue to live in Him as long as He lives. After the body falls I do not know in just what state of consciousness I shall be. I may be potentially conscious only, my life like a seed which awaits the time of planting, but by His life-energy I shall awake and be reclothed with a new and spiritual body which shall be incorruptible. Jesus said, "Because I live ye shall live also."

Chapter XVII

The Three-fold Principle of Nature Prefigures the Triune Spirit

In the unfolding of universal design, as we have progressed step by step, the two-fold, or dual principle, in nature has been fully demonstrated. It was necessary to make this principle very clear before the third principle could be introduced, because upon the existence of the two-fold principle depends the existence of the third principle; and also, upon a definite understanding of the characteristics of the two-fold principle depends our ability to understand the nature of the third principle.

The third principle will be introduced, first, by a purely artificial illustration, and from thence we shall endeavor to show that the three-fold principle is present throughout the mineral, the vegetable, and the animal kingdoms and that the third principle which depends upon the dual principle for its energy is the reproductive or creative principle in nature.

The artificial illustration is found in electromagnetism. The dynamo, the generator of electricity, is a great electromagnetic nucleus. The electric conductor which transmits the electromagnetic energy from the positive pole of the dynamo through long distances outwards

and eventually circles back to the negative pole of the dynamo is an artificial electromagnetic field. Now suppose the electrician desires to do some kind of useful work with his dynamo and conductor in which there exists, when operated, the dual principle of electromagnetism. He sets his dynamo to work and sends a current of electricity through the wire, and awaits the result. Nothing useful is accomplished. He simply burns out his machinery. He cannot even make a light without putting a piece of carbon in the system—a sort of third principle energy. But if he wishes to perform mechanical work of any kind whatsoever he attaches a motor to some part of the conductor. The motor is a machine constructed on the principles of the dynamo, and when put into the electromagnetic system where it occupies a central position so as to be acted upon by the kinetic and the potential energies of the system it transmits the entire energy of the hitherto dual, but now trinue system to whatever kind of machinery may be connected with it. Thus cars are made to run, factories are made to spin, and all of man's inventions are rendered useful.

Coming now to the natural systems of the inorgamic world we shall begin with the solar system. We are already quite familar with the constitution of the sun, how it is an exceedingly

powerful magnet, with a magnetic field hundreds of millions of miles in diameter. But the sun and its field alone, when representing only the two-fold principle, cannot accomplish any great work. There is, however, a third principle always operating in the sun which is constructive and creative in its energy. Those who have followed us through the Physical Realm know that in the photosphere of the sun, a region located between the sun as a nucleus and its magnetic field, there is an envelope of molten and gaseous matter. They know also that this solar photosphere is divided at the equator into two vast hemispherical cyclones; that in each of these cyclones in the region of the 30th parallel of each hemisphere there is a condition of high pressure, owing to the east and west components of cyclonic motion which force the atmosphere excessively into those localities.

Consequently in those latitudes of high pressure the fluid matter is thrown into eddies, or gyrations horizontally, having a terrific ascending motion. These energies become awful tornadoes carrying masses of matter as large as small planets thousands of miles into the upper regions. The perpendicular and horizontal gyratory motions in these masses of matter are those existing in the cyclone and the electromagnet which have been shown to possess the two principles

of organized matter. The tendency therefore, in the elevated masses of matter in the sun's photosphere is to form new spherical systems, and if the energy were sufficient the erupted matter could probably be thrown so far away from the sun that it would not again return. An instance showing this tendency was witnessed in 1859 by Professors Carrington and Hodgson. They were in separate places studying sunspots, at the same hour, when suddenly, *"They simultaneously saw two luminous objects, shaped something like two new moons, each about eight thousand miles in length and two thousand wide, at a distance of some twelve thousand miles from each other. These burst suddenly into sight at the edge of a great sunspot with a dazzling brightness at least five or six times that of the neighboring portions of the photosphere, and moved eastward over the spot in palallel lines, growing smaller and fainter, until in about five minutes they disappeared, after traversing a course of nearly thirty-six thousand miles." Possibly in this manner the nuclei of the planets were formed. In any case, this cyclonic formation in the photosphere of the sun tending to create new worlds is a third principle sustained by the dual energy of the sun and its field. Now without entering into an investigation as to how the planets came into existence we observe

* The Story of the Heavens, by Sir Robert Ball, p. 135.

that they were formed and do exist as a third individuality in the solar system. Without our earth as a third individuality in the solar system nothing could be accomoplished. The system could only burn itself out uselessly. There could be no organic existence, no beauty. All would be chaos. So the earth representing the third principle or individuality, in the solar system, is the soucre of life in that system.

Although we cannot see what is occurring in the minute systems of creation, nevertheless, as all systems, from the atom to the sun system, are supposed to be similarly constituted we may believe that in all of them from the largest to the smallest there are the high pressure latitudes where the third principle energy tends to form new creations.

Every intelligent person now knows that the earth is such a three-fold system. Meteorology has shown that it has the two hemispherical cyclones; that at the 30th parallel and thereabouts, there is high atmospheric pressure, and that in consequence, in these zones, secondary cyclones are continously formed, which possess constitutions like the primary cyclones. Here also, in the photosphere of the earth, between the earth's nucleus and its electromagnetic field, is a third principle arising from a resolution of the dual energy of the earth's cyclonic system.

Though the two-fold system composed of the earth and its field exists it alone can do no useful work. Moreover though the hemispherical cyclones exist they are powerless to water and fructify the earth, until within them the third principle energy embraced in the secondary cyclone is formed. It is the secondary cyclone which causes the changes of the temperature and brings the rain and the snow. Experience has demonstrated that without it the earth would be barren. To it we owe the beauty and the comfort of earth; yea, our very existence depends upon it. Again, we see that the third principle in natu e is present and is creative in its tendency.

In vegetable life also the three-fold principal is manifest even in a more interesting manner than in the inorganic creations. As elsewhere alluded to the trunk of the plant is a nucleus while the roots and branches constitute the field. As in other systems, there exists in the tree or the vegetable a dual energy constituting a cycle, one part of which is kinetic and the other part potential. This is demonstrated in the circulartory system of the plant. Plants have no central organ like the heart of the animal as a nucleus for a circulatory system, but the trunks of plants form a sort of reservoir, or basin, into which the roots pour the water and nutritive substances which they absorb

from the soil. The circulation upwards is performed under strong pressure.

Professor S.H.Vines says of this pressure, * "It is a matter of common observation that, when the stems of vascular plants are cut across, particularly in the spring, an escape of water takes place from the surface of that portion of the stem which still remains connected with the root, an escape which may persist for some considerable time. It has been ascertained that this outflow of water takes place under considerable pressure ; for instance, Hales observed, in the case of a vine, that the pressure was sufficiently great to support a column of mercury 32 and ½ inches in height. But the root pressure not only manifests itself by causing a flow of water from the cut surfaces of stems, it also causes in many plants the exudation of drops of water at the free surface."

There is a distinct loss of water from the leaves by a process of evaporation called "transpiration." For the supply of their water the leaves draw from the trunk of the plant. In this transpiration action experiments by different persons have shown that while there is water in all parts of the woody fibre of plants there are currents which flow upwards through the newer formations of wood. These currents carry the nutritive substance taken from the soil up into the leaves where, by a process of respiration, they are

* Encyclopedia Britannica, Vol. XIX, p. 46.

chemically transformed and carried downwards to trunk and roots through the inner bark, and distributed to the different cells of the plant as food. Of this dual—upward and downward—circulation in the vegetable kingdom Prof. Vines says, "The importance of the wood and of the bast respectively as conducting tissues is well illustrated by the 'ringing' experiments which have been repeatedly made on plants, such as Dicotyledons and Conifers, which have the fibro-vascular bundles arranged in a ring in the stem. When a ring of tissue, extending inwards as far as the cambium-layer, is removed from the stem of a dicotoledinous plant the following facts are to be observed: (1) that the leaves which are borne on branches arising from the stem above the level at which the ring of tissue has been removed will not exhibit any signs of withering: (2) that the part of the stem below the incision will not increase in thickness to nearly the same extent as the part above the incision. From these facts it is clear (1) that the operation in question has not materially affected the conduction of water and food materials in solution upwards to the leaves, and since the wood is the only unimpaired tissue, it is obviously in the wood that the upward current travels; and (2) that the operation has materially affected the conduction of organic nutrient subtances to the parts below the incision,

the diminished growth of these parts being the result of inadequate nutrition; this effect of the operation is to be ascribed, principally at least, to the destruction of the continuity of the bast-tissue."

Perhaps every one has observed the joints and knots in timber, and that in such places the grain is gnarled and more dense than in other parts of the tree. This is especially noticeable where a branch shoots out from the trunk and at the sections marking each year's growth. In these places and at the ends of the branches the uniform flow of the tree's circulation is interrupted, more than the usual amount of material is deposited by the flow of the sap upwards and the nutritive elements downwards, and high pressure and excessive nutrition are the result, while the flow of energy sometimes takes the form of a little eddy or cyclone. It is especially worthy of observation that only at such places as the above, in the tender growth where activity is greatest in vegetation do flowers and fruit appear. Therefore in the vegetable kingdom as well as in the mineral it is in the high pressure areas, where the system is subjected to the strongest pressure between the kinetic and the potential forces that the reproductive, or creative, principle asserts itself as a third energy in the system. These principles harmonize with the fact discovered by biologists that

the development of the life-germ is a product of accelerated nutrition. In the seed thus formed there is potentially a perfect embryo plant already containing the elements of root and leaves. This embryo is a fac-simile of the parent tree. We can see how this may be accomplished by knowing that there is a secondary dual energy set up in these fruit bearing parts of the tree in the exact likeness of the larger and primary dual energy of the parent stock. How wonderful this third principle is, always an intermediate principle between the two forces of the dual energy which supports it, and always a reproductive or creative principle, reproducing all the primary characteristics of the parent individuality.

If we now pass over into the animal creation we shall find the triune principle of nature existing there also. It has already been shown that animals, in connection with each set of functional organs, possess a nucleus and a field such as are necessary to duality, and that these several sets of dual organisms are united together in one system so constituted that the brain, with its dual sets of nerves, presides over the entire animal organism.

The brain and the nervous system centering in it being thus the controlling dual energy of the animal constitution, we should expect to see, in harmony with the law of the third principle present everywhere else, a third individuality de-

veloped somewhere in the nervous constitution of animal organism. Moreover, the animal being a very highly developed individual, with many different sets of dual organs performing the numerous functions of the body, we are prepared to find reproductive organs under the control of the nervous system, whose sole functions relate to the third personality of the individual. By the nerves the nervous energy is carried out to all parts of the body from the brain, and from the extremities the energy is carried back to the brain, the direction in which the energy is exercised in the first instance being precisely the opposite of what it is in the second instance. Thus the action of the brain and the relation to the nerves is similar to that of the dynamo and the conducting wire, one-half the energy being positive and the other half negative, and one-half always acting in direct opposition to the other half.

According to the conditions underlying the third principle in the mineral world and also in the vegetable kingdom, there is sure to be somewhere in the centre of the dual nervous energy of the animal, a place of high nervous tension and that place will be the location of the third individuality of the animal and of the reproductive organs belonging thereto. This condition, we find, does actually exist in the animal constitution.

The animal is created of electromagnetically constituted matter, and we know moreover that there is considerable electromagnetism connected with the animal body. The molecules composing the animal are in continuous motion. They doubtless rotate on their axes, transmit energy by means of their positive and negative poles, and through the nervous energy which rules over them they build and tear down systems.

Each molecule is consequently a small system of its own constituted on the model of the larger system. It is nourished by each functional system of the entire animal body. Therefore, it is sensitive to all of the nervous impressions made upon it by every part of the animal organism. Such being the case it is quite conceivable how the constitutions pertaining to the third principle of the vegetable and animal creations should bear the image, even to the minutest characteristic of the parent stock. The creations of the animal third principle possess, in embryo, all the vitality and the life of the primary dual system to which they belong.

Now, what shall we say of the three-fold principle of nature? Search where we will, in whatever kingdom of nature we choose, everywhere, there is a dual system and ensconced in it somewhere between its kinetic and potential forces, there is a third, a creative, a reproductive principle

as real and as potent as either principle of the dual individuality. Nature, without her triune energy could nowhere have performed her functions in the universe. If the two-fold system—the nucleus and its field—is a product of Almighty Power, so also, is the third principle of nature. And if the dually constituted creations are in God's image, so also is the third individuality of nature in the image of God. Therefore, whether we look backwards, through nature, into the eternity of the past, or forwards, through the pages of revelation, into the eternity of the future, we shall see one sentence indelibly inscribed in letters of gold on the scroll of heaven and earth. It is this: "The Three-fold Principle of Nature Prefigures the Triune Spirit."

PART III

The Spiritual Realm

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Chapter XVIII

One God in Three Personalities

In the face of so overwhelming an amount of positive evidence supporting duality as there is it is difficult to understand how any thinking mind can doubt the existence of this principle in nature, notwithstanding that to many persons the subject may be comparatively new. Duality, under one or another of several designations, as the "kinetic and potential," the "positive and negative," the "active and passive," or the "subject and object," exists in every physical system, forming couples, and cycles of energy. And somewhere between the oppositely directed dual forces of every system there is embedded a principle of energy more or less developed and active, which, under favorable conditions, or at a time of maximum energy of the system, tends to reproduce itself by forming minute systems of dual energy and throwing them off from the primary system as undeveloped potentialities of the parent organization. The workings of this third principle of energy are seen most conspicuously in the reproduction of vegetable and animal life.

This dual principle embracing a third, a creative, principle constitutes a triune-principle in unity, in nature, which is a fac-simile of the Bible doctrine of three Persons in one God.

Every one acquainted with the history and doctrine of the Bible is aware that its view of God is monotheistic. A few passages of Scripture which refer to the unity of God are the following: * "Hear, O Israel! Jehovah our God is one Jehovah." ⁂ "Jehovah, he is God; there is none else." † "I am the first, and I am the last; and besides me there is no God." § "We know that no idol is anything in the world, and that there is no God but one."

But whilst Deity is definitely declared to be one God the Bible is no less specific in maintaining that in God there are the Father, the Son, and the Holy Spirit,—three in one. A few texts of scripture referring to each will fully establish the truth of this. ‡ "He shall cry unto me, Thou art my Father, my God, and the rock of my salvation." ○ "But now, O Jehovah, thou art our Father." ▵ "My Father, thou art the guide of my youth." ‖ "But your Father knoweth that ye have need of these things." Jesus habitually addressed God as Father, and he taught his disciples to follow his example in this respect. In many other places in scripture the Father is spoken of as a distinct

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* Deut. 6 : 4
§ I Cor 8 : 4.
▵ Jer. 3 : 4.
⁂ I Kings., 8 : 60.
‡ Psa. 89 : 26.
‖ Luke 12 : 30.
† Isa 44 : 6.
○ Isa. 64 : 8.

personality from the other persons of the Trinity.

Also Christ's personality, as distinct from that of the Father, is tanght by the Father himself when he says: * "This is my beloved Son, in whom I am well pleased." Like testimony is borne by Christ who said: † "He that sent me is with me; he hath not left me alone; for I do always the things that are pleasing to him." And again, ‡ "The Son can do nothing of himself, but what he seeth the Father doing: for what things soever he doeth, these the Son also doeth in like manner. For the Father loveth the Son, and showeth him all things that himself doeth; and greater works than these will he show him that ye may marvel. For as the Father raiseth the dead and giveth them life, even so the Son also giveth life to whom he will. For neither doth the Father judge any man, but he hath given all judgment unto the son; that all may honor the son, even as they honor the Father. He that honoreth not the Son honoreth not the Father that sent him."

The Holy Spirit's personality, as separate from that of the Father and of the Son, is witnessed by Christ in his promises to the church immediately preceding his crucifixion, as follows: § "And I will pray the Father, and he shall give you another Comforter that he may be with

* Matt. 3 : 17. † John 8 : 29. ‡ John 5 : 19–23.
§ John 14 : 16.

you forever, even the Spirit of truth." Also, * "It is expedient for you that I go away; for if I go not away, the Comforter will not come unto you." And finally the three persons in one are clearly and strongly emphasized by Christ in the great commission to the church: † "Go ye therefore, and make disciples of all the nations, baptizing them into the name of the Father and of the Son and of the Holy Spirit."

The Bible teaches not only that there are three persons in one God but that he is omnipresent. "Behold heaven and the heaven of heavens cannot contain thee." Here there are three persons in one, filling the immensity of space, or of the universe. He is represented as infinite in power, and eternal as to his existence. Also, He is declared to be the creator and sustainer of all things.

The Father is the centre, the source, the great nucleus of energy upon which all else depends. He speaks of the Spirit as my Spirit, and Christ looks up to him as Father and says that without him he can do nothing. All, therefore, centres in and depends upon the Father.

The Spirit is the infinite field in the Godhead. Like as the strength of the electromagnetic field is equal to the strength of the magnet, and as the strength of the anti-cyclonic area is equal

* John 16:7. † Matt. 28:19.

to the strength of the cyclone, so the power of the Spirit is equal to the power of the Father on whom He depends.

Christ, who is said to be the only begotton Son of God is an intermediate person between the Father and the Spirit. Whilst Jesus was a Son, according to St. John he was in the beginning with God, and he was God. "All things were made through him; and without him was not anything made that hath been made." Whilst teaching that he could do nothing of himself He said that he could do all things through the aid of the Father who sent him. He said: "All power is given unto me in heaven and earth." He is therefore like the Holy Spirit dependent upon the Father, but that he might do the will of God there was conferred upon him the entire power of God.

Here we have in the Bible, a book which professes to be the revelation of God to men, a teaching concerning the Trinity of God in his Unity which shows Him to be the antecedent, of the three-fold principle in nature. A careful study of nature and revelation shows such a similarity between the triune constitution of God and the triune constitution of created things as to demonstrate that creation is the work of God. The Bible was written long before men knew anything about the constitution of matter as

understood to-day ; therefore the theology of the Bible as it refers to the Trinity could not have been borrowed from a knowledge of natural law. Its complete agreement with natural law could scarcely have been a mere coincidence, and we are shut up to the conclusion that the Bible teaching of God is a true revelation of him.

Not the least remarkable agreement existing between the physical and the spiritual constitutions is that of the intermediate or third principle of nature, as the begetting or creative principle, being in such perfect accord with Christ, the intermediate person of the Trinity, through whom all things were made. In relation to this agreement as to principles governing the two it will be profitable now to emphasize the existence of an important law which applies to both the physical and the spiritual realms, and which has hitherto been only incidentaily referred to ; namely, the emptying process necessary whenever work is to be done. Attention has already been called to the fact that when any physical system does work on an outside system its own energy is reduced by an equivalent of the work so done. In other words the system doing work has emptied itself of some of its own energy. Moreover in following the third or creative principle through the inorganic, the vegetable, and the animal kingdoms we saw that in the

formation of new systems or individuals it came about throug a tendency in the primary system to throw out some of itself, that is, through a process of emptying. Therefore it is probable that in some sense God, when he created matter and formed the worlds emptied himself. Likewise Christ, even in a greater sense, that he might give himself a ransom for the world, emptied himself, for of him it is written : *" Who, existing in the form of God, counted not the being on an equality with God a thing to be grasped, but emptied himself, taking the form of a servant, being made in the likeness of men ; and being found in fashion as a man, he humbled himself, becoming obedient even unto death, yea, the death of the cross."

In both the physical and the spiritual worlds, in the natural and the supernatural, wherever the creation of new life is involved the emptying is two-fold in its character. This two-fold emptying in nature is beautifully demonstrated by the germinal life which lies enfolded securely in the bud of the tree. When the bud opens the heart of it is found to be surrounded by green leaf, gorgeously colored and delicately scented flowers. Later this little life is enveloped in an environment of radiantly tinted and deliciously flavored fruit. In process of time it leaves, or empties itself of all this beauty, and fragrance, and delicious-

* Phil. 2 :6—8.

ness, and security in the parent tree and falls down into the cold and unfriendly earth where it may lie for weeks or months trampled upon by wild beasts or the foot of man and exposed to great danger. But after all this emptying and sacrifice nature demands that it should empty itself yet once more. The seed shell must burst and decay. The inner vegetable matter also decomposes, and some of it through chemical processes becomes food for the new life of a tree.

Jesus also emptied himself in a two-fold manner that he might bring life and immortality to light through himself. First he left his glory with the Father, that is emptied himself of it, and came down to earth to be made sin for us. That he emptied himself of his heavenly glory is shown by his prayer to the Father immediately before his crucifixion, in which he said, *"And now, Father, glorify thou me with thine own self with the glory which I had with thee before the world was." In the second place he emptied himself at the cross. He said, †"I lay down my life for the sheep." And on another occasion, "Except a grain of wheat fall into the earth and die, it abideth by itself alone; but if it die it beareth much fruit."

Thus the whole universe on earth and in heaven crieth out that there is one God. That

* John 17:5.
† John 10:15.

in him there are three persons; that all things were made by the Son or intermediate Person, and that there could be no eternal life for men except through the Son's two-fold emptying himself for us.

The benefits of the Son's emptying himself come to us through the Holy Spirit. Energy is always transmitted from one body to another, in case the two bodies are separated, by some intervening medium. The sexton, when ringing the church bell, transmits the energy from his arm to the bell by means of a rope and gravitation. The vibrations thus caused in the bell are transmitted, through waves produced in the atmosphere, to our ears. So the energy sent out from the hand comes to us as melodious sound. Were it not for the intervening air this would be impossible. Again, you enter an unheated apartment in winter and suffer much discomfort from the cold. Presently you begin to feel warm and your discomfort is dispelled because your environment has been brought into harmony with your physical constitution. Somewhere in the basement of the house coal or other fuel, through combustion, is being emptied of its energy. This energy is radiated and comes into your room through the steam pipe or other apparatus and is transmitted to your person through the medium of the atmosphere. In leaving the glory of

heaven and coming into the world and dying upon the cross Jesus Christ emptied himself of sufficient spiritual energy to recreate the race of mankind in his own image and make them children of himself. This glory, power, energy, and life of which Christ emptied himself was not lost. No energy is ever lost. Energy radiated, or expended, or emptied out, must find a resting place some where else. Christ's power and life, when emptied out of himself, entered into the Spirit, the medium which fills infinity, to be conveyed to lost men for whom Christ died. Consequently this most precious and costly energy in the universe, now embodied in the Holy Spirit, will not find a resting place until it finds it in the spiritual consciousness of the races of men of the whole earth.

Chapter XIX

The Ethical Principle

The dual principle which we have seen existing in the world of matter and traced back to God, the Creator, exists also in the world of morals. In man's mental and spiritual nature there are two forces, one recognized as being good and the other as being evil which war with each other for supremacy in controlling the life of the individual. This fact has been in some degree recognized by man in all ages of the world and in every clime. The principle cannot be attributed solely to the fall of man, because if the principle of moral responsibility had not existed before man fell he could not have fallen. No one ever more truly and pathetically expressed the workings of this moral dualism and the strivings of the human soul in an endeavor to do the good and shun the evil than did Paul, when, in the anguish of his spiritual nature, he said, * "For the good which I would do I do not: but the evil which I would not, that I practise. But if what I would not, that I do, it is no more I that do it, but sin which dwelleth in me. I find then the law, that, to me who would do good, evil is present. For I delight in the law of God after the inward man: but I see a different law in my

* Rom. 7: 19-24.

members, warring against the law of my mind, and bringing me into captivity under the law of sin which is in my members. Wretched man that I am! who shall deliver me out of the body of this death?"

The existence of evil in the world is a mystery which has puzzled and distressed the human mind more, perhaps, than any other problem, and God has often been unjustly arraigned by human wisdom and charged with being unjust and unloving to create us subject to pain, and sin, and death; while others have gone so far as to deny the existence of a loving Creator, thinking the conditions of suffering and wrong are inconsistent with the idea of Fatherhood. But these views are held by a few, only because the nature of the case is wholly misunderstood by them. If duality is necessary to the existence of physical systems and is a part of the very nature and character of God, as it has been shown to be, it is also a necessary concomitant of man's moral being. In the very nature of moral principles this can be shown to be true.

Reviewing our position from the standpoint of physical systems the dual principle, forming a couple, is not only essential to the existence of every system, but the two parts must contain their equality of action in relation to each other

in order to satisfy the conditions of continuity. This signifies that there must be as much energy directed towards the centre of any system by the potential half of it as is directed away from the centre by the kinetic half of it. The energy of the magnet is equal to that of its magnetic field. The force of atmospheric motion in the cyclone is equal to that of the anti-cyclone. The energy in the roots of the tree is equal to the reactionary enery of the leaves and branches. The constructive forces of the living cell are exactly balanced by the destructive forces of the cell. If, in any system, either the kinetic or the potential force, or, the constructive or the destructive channel, becomes exhausted or choked in the performance of its half of the circulation of the energy of the system, that system soon ceases to be. Any considerable variation from the balance between the two forces of energy brings the system to grief.

As, in the universe, nothing can come from nothing, and as, when any system expends energy on an outside system its total amount of energy is reduced by the energy thus expended, it follows that when one half of a system spends energy on the other half of the same system the energy of the first half is proportionately diminished if the second half of the system does not reciprocate and send back

as much energy as it received, and thus maintain the equality of action and reaction. Therefore when God, as Father, sends His creative and sustaining energy out of His Person into the Holy Spirit, which is his potential Personality, His power as Father must be diminished by the amount of energy with which the Spirit is thus invested, except there be in His constitution a means whereby a Spiritual power flows back from the Holy Spirit into His Person as Father. As Infinite and Eternal Being this provision certainly must exist in His Person. All the energy which God gives out through the Spirit returns to Him as potential Spririt in the fulfilment of the cycle of Spritiual Being. There is therefore an equilibrium in God to be maintained similar to that of created systems in the animal and mineral kingdoms.

Wherever work of any kind is being done there is stress present in the substance acting or being acted upon, whether the substance be material or spiritual ; and wherever stress exists in a system it is the product of duality—two opposing forces—the action of which maintains a poise, or steady equilibrium, in the system. The maintenance of this poise in sentient beings is in part, at least, dependent on their own endeavors. The responsibility of rational creatures in this respect is very great. Its maintenance affects the life of

the individual, his posterity, and all that belongs to him. If God is subject to this law of being, as I think He is, it is easy to see how the question of maintaining this essential relation of the two Personalities in him is a moral one. Its maintenance, or non-maintenance, affects God favorably or unfavorably and therefore entails consequences upon himself and also upon all of His creation, especially His children. It concerns the question of His love for them and the exercise of all His moral attributes. It deeply affects the life and the work of the Lord Jesus Christ, He being dependent on God as Father for His life and work in the redemption of the world. The question of morality and character is then, in its essence, one which takes into account what conduces most to our life and to the lives of others, and vice versa. It is a problem of life and death.

The formation of character in an individual is a mental and spiritual work, involving a strain in the mind, the feelings, the ethical life of the person. This strain is related to the physical duality and also to the spiritual. True character has regard for the body and strives to maintain the physical poise necessary to the greatest efficiency and strength. Character relates to our neighbours. There are certain moral obligations which we should perform towards them, because

we cannot live apart from them and our contact with them affects their lives either favorably or unfavorably. Again, character relates to our obligations to God, because our lives came from Him and He constitutes a great part of the cycle of existence of each one of us. Therefore the positive and the negative, the kinetic and the potential forces for the formation of character are not merely a physical duality, but more especially a moral duality, and the strain consequent upon the struggle between the constructive and the destructive forces of our spiritual being is known as that of good and evil. This duality, by whatever name it be called, is absolutely essential to the life of every rational spiritual being, and if properly used becomes the greatest possible blessing. As our physical life is essential to our development and usefulness, and as this life was derived from God, our first duty is to Him in the preservation of our life for the furtherance of His interests in the world; and second, in the preservation of our life for the furtherance of humanity. Whether we turn Godward or manward our duty is to ourselves for the development of our powers that they may be exercised for the benefit of others. This is the foundation principle of the Spiritual Realm. A duty to preserve to our utmost ability the duality of our physical being; a duty to preserve

the ethical duality of our moral and spiritual life. Any undue leaning towards the constructive forces of our physical nature—as eating too much food—or, vice versa, too much inclining towards the destructive forces—as excessive work with too little nourishment—is, in either case, destructive of the bodily system, because it tends to disorganize the physical duality. The manner of the working of this principle in our spiritual nature may be somewhat difficult to understand, but it can be made more clear by an illustration. In magnetism the lines of force of the magnet, leaving the positive pole of the magnet, circle round through the field and re-enter the magnet at the negative pole. A secondary magnet in a homogeneous field is acted upon equally at both poles; and, though under a strain because of pressure, does not change its position. It is able to maintain a steady position in the field through the equality of positive and negative forces which act upon it. But make the field magnetically heterogeneous so that the small magnet is unequally acted upon by the dual magnetic forces and it will change its position—be driven away from the primary magnet if it is less magnetic than the medium which surrounds it, or, if it is more magnetic than the surrounding medium it will be drawn towards the primary magnet. The magnetic permeability of the sec-

ondary magnet as relates to its environment determines its relation to the primary magnet, and also whether it shall be regarded as a paramagnetic or as a diamagnetic body. In ethics our environment is heterogeneous. It is composed in part of Spirit. God's Spirit pulsates through us and draws us towards Him, but in our environment there are other elements which partake of the material and are not spiritual. They have at best, as relates to the Spirit, but negative values. They affect the poise between action and reaction, which, as moral beings we should maintain. We are consequently subject to two influences, one which draws us towards God and the other which repels us from Him. Like all physical bodies which are either paramagnetic or diamagnetic, we have either the "Mind of the Spirit," and are drawn toward God, or we have the "Mind of the flesh," and are repelled from Him. The mind of the Spirit is life and peace, but the mind of the flesh is death.

For physical quantities and energies we have standards of measurement and everything is good or bad, perfect or imperfect, as it conforms to the standard or diverges from it. This is also true in the spiritual realm. God is the standard of perfection there and by his perfect attributes we must measure the spiritual qualities of the human soul. For the ethical expression of our spiritual

qualities as compared with the moral attributes of God we use positive and negative terms such as righteousness and unrighteousness; purity and impurity; holiness and unholiness; justification and condemnation; life and death. The word which expresses wilful unrighteousness is sin. A variation in the degree of moral character as expressed in the couplets above produces a change in the consequences upon the lives of men corresponding with these varying moral states. From this is established not only the moral principle of good and bad, but also the principle of rewards and punishments In every religious system there is some kind of doctrine providing for rewards to the good and punishments to the evil. There is no religion, which, on this point, is more specific than is Christianity.* "The Son of man shall send forth his angels, and they shall gather out of His kingdom all things that cause stumbling, and them that do iniquity, and shall cast them into the furnace of fire, there shall be the weeping and the gnashing of teeth. Then shall the righteous shine forth as the sun in the kingdom of their father. He that hath ears, let him hear."

† "And these shall go away into eternal punishment; but the righteous into eternal life."

We have learned so much about God's mercy and longsuffering that many are concluding in

* Matt. 25:46.
† Matt. 13:41–43.

these days that it would be inconsistent with His love as a Father to punish His sinful children. But let no one be deceived. If there are penalties for the violation of every physical law, there are just as certainly penalties for the breaking of s iritual laws. The "hell fire" of the Bible is often made light of, but in the face of scientific facts, strengthened by strong Scripture declaration, I am not sure that the expression is either superstitious or figurative. In nature different degrees of the same energy produce different phenomena, especially upon the animal body. Parmagnetic and diamagnetic bodies represent different degrees of magnetic permeability—one being more permeable and the other less permeable than the atmosphere—but because of their difference of magnetic power their actions are wholly different. The sensations of light and heat are but different intensities of the same wave energy. Our sensations of heat and cold are directly opposed to each other as to their effects upon us, but one is merely the sensation produced by a wave energy more intense than the normal heat wave of the body, while the other is produced by a heat wave of less intensity than the normal heat wave of the body. In a very similar manner joy and sorrow are sensations representing different degrees of feeling, and love and hate are sensations representing different degrees of

passion. Cold is the negation of heat; sorrow is the negation of joy; and hate is the negation of love. It is apparent therefore that there are various intensities of the same kind of physical energy and there must be also different intensities of spiritual energy. Each of these, whether physical or spiritual, produces its own peculiar effect. This view is supported by a great deal of Bible testimony. Although God is omnipresent He is not everywhere at the same instant in the same intensity of the Holy Spirit's action. Consequently it does not follow that because God is love the action of the Spirit upon us will always produce a feeling of pleasure. Heat is absolutely essential to our physical existence and in the proper intensity produces in us the most delightful and healthful sensations. Too little of it causes sensations of pain; and too much of it will cause not only much discomfort but may burn and destroy our life. This earth is a beautiful place in which to live. It has been specially adapted to all of our needs, but through difference of temperature and climatic conditions arising therefrom there are many places in it where we cannot live. The polar latitudes are too cold for comfort and the tropics are too hot. In the ætherial regions a few miles above the earth the air is too cold and too attenuated for man to live in it. In the centre of the earth it is so hot that

death would instantly result to any one falling into it. Likewise there are places in God's kingdom exactly suited to man's nature as a spiritual being, but there are other places where he would suffer discomfort and at least one place where the sensation to the impenitent is like the burning of fire.

On the earth the place best suited to man's well-being is in the temperate zone in the limits of the 30th or 40th parallel—the place of high atmospheric pressure, or "ring of calms". Although it is a place of calm as relates to the terrestrial cyclone it is the place also where secondary cyclones form and by their action water the earth, rendering it fruitful. It is the product oft he dual energy of the terrestrial cyclone and its field, and is the area of the third principle energy of the earth's cyclonic system. Just so, in God, in the Third or Intermediate Person of the Godhead, between the Father as Source and the Spirit as the Omnipotent Universal Presence, is the place of safety and happiness for the soul of man. In the Person of Christ there is provision made for our every need, both now and in the world to come. In Him is life, and peace, and joy, forever. He is the attractive energy of God. He said,* "And I, if I be lifted up from the earth, will draw all men unto me." But though Christ draws all men He does not say

* John 12: 32.

that all men will come to Him. His drawing is effectual only when we allow the desires and affections of our minds to be drawn towards God. As iron is capable of magnetic inductivity so we are capable of spiritual inductivity from Christ, but if we refuse to become permeated with His Spirit, the power which, in the first case, should have drawn us, now, in the second instance, repels as magnetism repels a diamagnetic body whose molecules refuse to be alligned with the magnetic lines of force of the primary magnet. The laws governing the constitution of God's nature make it impossible for the Spirit-filled person and the Spirit-emptied person to occupy the same relation to Him and dwell in the same place in Him. When Jesus was transfigured on the mount his face and garments shone with glory. Also when Moses was on Mt. Sinai Jehovah said to him,* "Thou canst not see my face; for no man shall see my face and live." There is such radiant glory in God's person that finite sinful man cannot behold Him and live. In the radiance of light there is energy, and there is every reason to believe that in the Person of God, the Source of the energy which animates His own Being and moves the systems of the universe, there is a place where the Spirit's power, if felt by the sinner, would be like the pain of flames of fire. Neither the cold of the extremities of the earth

* Ex. 33: 20.

nor the burning lake of the earth's interior was made for man's abode, but both are a part of the earth's system which, as a whole, is so genial to his nature. So the place of intense energy in the Spiritual Realm which, to man's soul, burns like fire was not made for him, but is, no doubt, a part of the spiritual constitution which serves an important purpose in the Spirit's life. As no energy can be lost or dissipated from the Great Infinite Being there can be no doubt that even the wicked who come into this place of punishment, do, in some way, contribute to the life and power of God and His kingdom. This is indicated by the positive teaching of Scripture which testifies that the evil spirits who are finally destined to be cast into the lake of fire are now, for a season, permitted to inhabit the earth, and while Christ draws men to Himself, they, on the other hand, tempt them to reject the offers of mercy vouchsafed to them.

Our hearts should be drawn to God in more intense love because, in view of the duality of his nature as well as of our own, it appears that He does not love us on account of His nature being such that He must love, but He loves by his own free will. His acts are volitional, not mechanical and involuntary. He chooses therefore between two courses open to Him in all of His moral actions. Moral accountability involves such a

condition. Such conditions confronted Christ when He was tempted in the wilderness. God requires no more of His children than Himself is subject to. Moral rectitude, the power to decide and act in favor of a right course of procedure when two propositions—one right and the other wrong—are presented, is the highest achievement a moral being can attain. It lies at the basis of a correct life and of our attitude towards God. Our present and eternal destiny depends on it.

Chapter XX

The Sociological World-Nucleus

Sociology deals with the history of society, "how men became grouped into political communities, how they constituted authority and property, how they originated castes and guilds, and by degrees separated into high and low, rich and poor.

"Society develops intelligence, comfort, the sentiments of justice and equality, of fraternity, goodwill, and cheerfulness to a degree which would have been unattainable in a severe and prolonged solitude."

The gregarious instinct in the brute is, in man's consciousness, the social idea of brotherhood. It has its roots in the family conception, especially in the relation of the children to their mother and to each other. Sir John Lubbock tells us that, "Children were not in the earliest times regarded as related equally to their father and their mother; but the natural progress of ideas is, first, that a child is related to his tribe generally; secondly, to his mother, and not to his father; thirdly, to his father, and not to his mother; lastly, and lastly only, that he is related to both."

Professor Reclus tells us that,* "The family had its origin in the gathering of children around

* Encyclopedia Britannica, Vol. VII, p. 619.

their mother. These children became to one another brothers and sisters by the remembrance of the care they had enjoyed in common. They kept together; so did their children and their children's children: and the *gens* took shape and life.

"Probably the original horde was by degrees remodelled into tribes by the gentes which had taken birth in it. The word gens, equivalent to clan, sept, or totem being the best known of all, may be used in a general sense to denote all kindred institutions. The tribe became an organization of gentes. An Indian tribe, according to Lewis Morgan, is composed of several gentes, developed from two or more, all the members of which are intermingled by marriage, and all of whom speak the same dialect. To a stranger the tribe is visible, and not the gens. It is highly convenient for a tribe to contain at least two gentes, which, if they chose to intermarry, would find wives at their own door. A fundamental law of the gens prohibited marriage between gentiles, or members of the same gens. For most communities were deeply averse to consanguineous marriages, which they branded with the infamous name of incest, though some others held them to be highly commendable. The original rule was that all descendants by the same mother were to be regarded as brothers and sisters,

and they were soon forbidden to contract matrimonial unions. As there was no relationship by the father's side, the patriarch Abraham could in all propriety take his sister, or rather his half-sister, as a wife. And such a tribe, consisting of two gentes only, intermarrying constantly, might be composed of first cousins only, and be truly endogamous nevertheless."

The rights and duties of such a community, "Were the reciprocal obligations of help, defence, and redress of injuries against any one from without. They had the same religious rites and a common burial place....The gens was primarily a great motherhood, and the gentiles, all of them, were supposed to be brothers and sisters and to live in their mother's home.

"As in the course of time the gentes increased, they segregated to a certain extent, but maintained their association for certain common objects; the enlarged association was called a phratria or brotherhood. Each of the four tribes of the Athenians was organized in three phratrias, each composed of thirty gentes. The Roman *curia* was the analogue of the Grecian and the Iroquois phratrias."

The social idea in man is greatly strengthened by language and religion. "Formerly the words 'nations' and 'languages' were synonymous. In Genesis the confusion of tongues is said to have

caused the separation of mankind into nations. A language is to be considered as the collective brain of a nation; the vocabulary shows the richness of its ideas, the syntax how it works them. While our lexicographers count their words by the ten thousands, we are assured that the savage is scarcely able to use more than twelve hundred words, and that many English rustics have not more than four or five hundred words at their disposal. A nation's language is the sum of its developed intellect, the record of its previous intellectual efforts. From that store of accumulated ideas and feelings our children draw the best part of their information, the most of their morals. Our mother tongue is our intellectual motherland."

It has been said that religion has more influence on man than the affinity of blood, but less influence on him than the affinity of language, because language is the sum, and religion a part only, of his thoughts. It may be accepted as true however that while language has a very strong influence upon a nation, religion, as a world influence, is stronger than any other force in the earth. Religion lies at the very foundation of man's moral nature and social customs while language is little more than a means of communication The nature of religion is vital while any language, when acquired, serves the purpose of expression.

Language is not an incentive to action in the sense that religion is. It was Israel's belief in Jehovah, in the earlier days of their history, which kept them from affiliating with, and being absorbed by, other nations whose religions were idolatrous. Moreover, for nearly two thousand years they have been without a country, and almost without a language, scattered all over the earth, yet, for religious reasons, they have not become incorporated with any people, and have been cruelly persecuted in almost every land.

Notwithstanding the barriers of language it is religion, entering into the life and customs of the different peoples, more than language, which is a cause of separation between the peoples of the East and the peoples of the West. It is the religion of the Koran which has made the Turkish Empire the corrupt and cruel power it has been from the first, and created a gulf of separation between it and the rest of the world.

On the other hand it was the just and beneficent religion of Christ which overthrew the idolatrous religions of Europe, destroyed the despotism of Rome, and united the barbarous, warring tribes under civilized forms of goverment, thus laying the foundation for material, intellectual, and religious progress. It is the civilization growing out of, and in large measure based upon, the Christian religion which is touching

the nations of the East and permeating them with a new life. It is indirectly the force of Christianity which is causing the dead carcasses of Turkey, Persia, and Tibet, to show signs of life, through the object lessons which Christian nations are furnishing them.

What human agency could speak more for the vitality of a religion than the work of the British and American Bible Societies? The former alone, in the past one hundred years, has translated the Bible into nearly four hundred languages, many of which, by agents or missionaries, were, for the first time, reduced to writing. Millions of copies of the Scriptures, comprising all languages, are printed and sold annually. Again think of the mighty force of the Christian educational institutions in Europe and America, not to mention those which are springing up in Asia and other parts of the world! They constitute a bulwark for enlightenment and progre s whose power in the ethical world cannot be calculated in mathematical terms. Add to these the institutions of benevolence, unknown before the days of Christianity, which now dot the earth wherever the beneficence of Christ's kingdom has been felt, and the regenerating influence of the Christian Church can begin to be understood. No part of the world has yet become wholly Christian, but in every

clime, just in proportion as His Gospel has entered and ruled the lives of the people, society has been purified and lifted into living fellowship with the Almighty Father which relationship makes us feel that we are all brethren.

But notwithstanding the visible evidences of the superiority of Christianity, if we fail to perceive its underlying principle in relation to the constitution of all things we shall not be able to profit fully by a consideration of the paramount claims which Christ has upon the world. There is a science of Christianity which coincides with the science of the universe. It is the principle of the nucleus and its field. A retrospect shows the nucleus and a field of corresponding energy in all systems in the universe of matter—the magnet and its field, the cyclone and the anti-cyclone, the vegetable seed embracing the germinal-nucleus enclosed in a larger covering of starchy matter as a potential field, likewise the living animal germ-cell always containing a nucleus encased in a mass of protoplasm as a potentiality, all prove the universality of the nucleus principle operating in each complete physical system. Both philosophy and revelation show that the principle is present also in the Spiritual Realm, in God. The Father is the Source, the Centre, the Nucleus, while the Omnipresent Spirit is His potentiality, the field. Psychologically the Father is the subjective

while the Holy Spirit is the Objective Personality. In sociology also we find the nucleus and the field. In the family the mother (or the father and the mother), the centre, around which the family of children are the potential element. In the nation the nucleus consists of the ruler and his government, while the field is constituted of the people. In the larger social orders, as a nation, usually the ruler and the ruled—two halves of the system constituting the whole—grow up together. In the vegetable and the animal kingdoms the nucleus and the field of the germ appear to be produced simultaneously, through the action of the kinetic and potential forces represented in the male cell, as the kinetic, and the female cell as the potential, energy of the reproductive powers. So in the religious development of society there must be a sociological nucleus who can vitalize the lives of men and incorporate them into his own life, so that they may constitute one living system, society being the potential field of the organism. The nucleus cannot be wholly a creation of society any more than the ovum of the mother can produce the germ, nor can he be wholly of God apart from human existence, for in that case he would be completely outside the social organism and incapable of being a part of it.

Seeing that religion necessarily enters any discussion of sociological questions, it may be

well for us, before proceeding further, to define what we mean by religion. Some ethnologists have given this definition of it: "Religion is the feeling which falls upon man in the presence of the unknown." But why should man fear, or love, and personify, and endeavor to propitiate the unknown, while the brute does not? It is on the principle that the telephone receiver is capable of conveying sounds to the ear which a wire inserted in a wooden receiver cannot do, because the former is of finer mechanism than the latter. Man is of finer and higher mechanism than the mere animal. He possesses something of the nature of the divine Father, and is capable of receiving influences from him. This being true the ethnological definition falls short of the whole truth. The following definition is more comprehensive: "Religion is a habitual, all-pervading sense of dependence on, reverence for, and responsibility to, a higher power." According to the principles of psychology man's impressions come from and partake of the nature of his environment. Therefore his ability to reach out and grasp the conception of God depends upon the fact that God is, and that man is so constituted that he can receive mental impressions which come from God. Consequently man's spiritual and religious objective, in psychological terms, is God. God is wholly spiritual. Man is some-

what spiritual. God is infinite, while man is finite.

Both sociology and religion contemplate brotherhood, but brotherhood involves fatherhood. A brotherhood without fatherhood is impossible. Thus it becomes perfectly apparent that if there is to be a world Brotherhood it must be consummated by Fatherhood in God, as any thing lower than divine Fatherhood is absolutely inadequate. No substitute can raise man to a high moral and social plane and effect brotherhood relations. We have come from God by a process of creation and from the earth by a process of birth. Having been born of earth and possessed of only some of the spiritual characteristics of God we are not yet complete. It remains for us to be born of God in order to become children of Him as our heavenly Father and thus constitute a divinely human Brotherhood. This sonship cannot be according to the physical body, but must be by spiritual processes. How can this work be accomplished? For answer, let us take the words of Christ, "The world—mankind—is the field." We should bear in mind that a field is the potential half of a dual system. It has latent powers, but is incapable of generating life. It wants the kinetic energy of the nucleus of the system to make it effective. If the potentiality of the World's Brotherhood is humanity, potential but helpless humanity, what is the kinetic and

life-giving nucleus of the Brotherhood? The life of the seed, and the life of the animal germ-cell, are the nuclei, the living organisms. The living nucleus is higher in its nature than the protoplasmic field which enfolds it. Just so, the living nucleus of the World Brotherhood must possess in Himself the principle of spiritual life. He must be far higher than humanity. He must possess in Himself enough spiritual power to quicken into life the whole human race which is his potentiality. He can be none other than a God-man. A God-man as a living nucleus and a spiritually potential humanity can constitute a World Brotherhood, and nothing short of this can do it.

We have now a philosophic basis for a World Brotherhood upon scientific principles. But the question naturally arises, does the history of the world confirm the theory? We answer that Christ and his Church fully justify the scientific basis reached. Let us start with the natural phenomenon that in living cells the nucleus and the field develop simultaneously, the nucleus or germ-life gradually rising to a higher and more perfect organized state than the other and larger part of the germinal cell. In the formation of the vegetable seed in all higher organisms sexual action takes place between the male and female plants in which have been previously evolved

the two individualities of life—that of the male being the smaller, the more active, and apparently living kinetic substance, while that of the female is a much larger, less active, sack-like organism, whose function seems to be to receive the male germ. In the process of gemination a seed is formed containing the two divisions—the living germ, the nucleus and a surrounding comparatively large sack of starchy food material which constitutes the field or potentiality of the dual life. If the germ of the seed be killed by cold or other means the seed perishes. In the animal world the principle is the same. The ovum, or egg, of the female, receives the active living cell of the male and an animal germ-cell is developed which likewise is a cell of protoplasm possessing a a living nucleus, while the larger part of the cell is its potentiality. If we now turn to humanity we shall see that a like process sociological and religious, has been going on in the world, commencing almost with the beginning of man's life in the world. Humanity as a whole has had an innate sense of the existence of some kind of superior being, or beings, whom it has feared and propitiated, but this sense has been dim, clouded by sin, superstition, and idolatry, often of a very low form. While some of the ethnic religions have been superior to others none of them have possessed a clear knowledge of

God and His attributes, and of the relation which He bears to men; and most of them have been destitute of a knowledge of the existence of one supreme Being, the Creator. Consequently the moral, social and intellectual conditions of the human race as a whole have remained on a comparatively low plane. But whilst humanity as a whole occupied different degrees of a low plane there was one small branch of the human race, a branch descended from Adam through Enoch, Noah, Shem, Abraham, and David, who rose much higher than other branches in ethics and religion, and who, in the midst of many failures and difficulties held tenaciously to a belief in, and and service to, Jehovah God. Through them came a moral law—the decalogue—which remains till this day the basis of the ethical laws of all Christian nations. Moreover, it is broader than mere ethics, as it relates not only to Man's social relations, but embraces also his religious obligations to God, his Creator. This race so distinct from all others, became a nucleus of moral and spiritual influence in the world in the pre-Christian era, and by direct spiritual contact with God brought forth Jesus Christ who Himself claimed to be not a prophet, or a hero, but the Son of God, whose coming had been foretold in the Hebrew Scriptures by many prophets.

The Scriptures declare that God manifested Himself to Abraham, the immediate ancestor of the Jewish people, and made promises to him and his posterity of a remarkable nature. They were to be a chosen people, to become numerous as the sands of the sea, and be a great blessing to the world. To Abraham Jehovah said: * "Unto thy seed will I give this land." Also, † "I will make thy seed as the dust of the earth." Again, ‡ "And I will establish my covenant between me and thee and thy seed after thee throughout their generations for an everlasting covenant, to be a God unto thee and thy seed after thee." And in regard to their influence upon the world Jehovah said: § "And in thy seed shall all the nations of the earth be blessed; because thou hast obeyed my voice." Centuries later, Jehovah, speaking through the mouth of the Prophet Isaiah, said: ‖ "For thou shalt spread abroad on the right hand and on the left; and thy seed shall possess the nations, and make the desolate cities to be inhabited." Also, Jehovah, foretelling the birth of one who should eventually come into the world, through His chosen people, said: ¶ "For unto us a child is born, and to us a son is given, and the government shall be upon his shoulders: and his name shall be called Wonderful, Counsellor, Mighty God, Everlasting Father, Prince of Peace.

* Gen. 12: 7 † Gen. 13: 16. ‡ Gen. 17: 7.
§ Gen. 22: 18. ‖ Isa. 54: 3. ¶ Isa. 9: 6-7.

Of the increase of his government and of peace there shall be no end, upon the throne of David, and upon his kingdom, to establish it and to uphold it with justice and with righteousness from henceforth even forever. The zeal of Jehovah of hosts will perform this."

From the Scripture standpoint the above quotations clearly establish the fact that the Jews, or the seed of Abraham, were a chosen seed and that Christ whose birth the prophets foretold was the nucleus of that nation. He was the one in whom the whole nation centred and for whom it was raised up. He was a Prince, yea more, He was the Son of God. Here we have in the world a seed consisting, on the one hand, of the greatest person ever born into the world, and, on the other, of the chosen nation to which He belonged. Like all other seeds, this one also consisted of two parts. Christ the nucleus or germ, and the people, the potential field. When a vegetable seed begins to grow the germ acts upon its environment or field of starchy food, portions of which are gradually absorbed into the germ and changed into living tissue. By a process of growth a new plant is evolved, while the small store of food enclosed in the field of the germ-cell gradually becomes exhausted; but now, behold, the new organism has acquired so much vigor that it reaches into the

world outside for its food supply, this outer enviroment now having become its objective, or potential field. So, as the new life enlarges and reaches out more and more after food materials, the dead particles are increasingly taken into its system and converted into living cells which in turn become a part of the dual plant organism. There is no more beautiful example of the working of the seed-principle in its dual action than is presented in Christ and His Body, the Church. He declared from the beginning that while His Gospel was for the world He was sent to the Jews only. When He began to work, and to preach to the Jews, a spiritual transformation set in among those who heard Him, and a new and living society sprang forth, having its roots in the old Jewish stock, but itself rising heavenward. It was a spiritual Brotherhood having within itself the life of God. Christ was that life, the nucleus, and He gave of His own life to all of His own race, the seed potentially, who would suffer the regenerating power of God to change their sinful hearts and make them, individually, parts of the spiritual Body of Christ—the kingdom of heaven on earth. As time passed by the new society had drawn into itself and changed such parts of the Jewish seed as would yield themselves to it, and the rest were rejected, like the

growing plant rejects the old seed-shell and other irreducible portions of the once beautiful seed. The irreconcilable Jews, the Jews potential with so much possibility for good and happiness, who were rejected are to-day pitiful wanderers in the world. They deserve our sympathy and help as do no other class of people on the face of the earth. But the growth of the kingdom of heaven did not stop. True to the law of growth, when the seed potentially was exhausted the new life, the new organism, reached out farther, and the world,—humanity,—became its field, its potentiality. Christ sent His apostles to the gentiles, to the uttermost parts of the earth, and the kingdom of heaven has taken root over the whole world and is rapidly growing into a living and all-embracing Brotherhood.

The growth of the kingdom is a psychological and spiritual work. The nature of this work can be best illustrated by an individual as relates to the union of his mental and physical being. Psychologically, when the mind alone is considered it is the subject, and the body is the object. They act and react on each other and the two parts constitute the individual. Just so with Christ and His mystical or spiritual Body, the Church. Himself is the subject, and they, collectively, the Body. The living believer is verily a part of Christ. The life of the blessed Savior flows out

from Jesus into the Church, His Body, and back to Him bearing the fragrance of their responsive worship and service. But this is not all. When a man looks upon himself, his whole person, as the subject, and then at his clothes, his possessions, his relatives, his family, he says of them all, "They are mine." They are his. He thinks of them not as being apart from himself but as part of himself. They are his objective "me." He and they act and react on each other. The things he calls "mine" are inseperable from him and his mental being so long as they occupy that relation to him. They are a part of his life, of himself. So Christ with the Church, in relation to the world of mankind, is the subject while humanity is the object. There are several senses in which Christ can say of the human family, "They are mine." Humanity is part of Himself by the fleshly relationship He sustains to it. It is His by virtue of the sacrifice He made for all men. It is His by the bond of undyng love. His soul goes out to the world in the yearnings of parental affection. He says of them, "They are my brothers." They are His objective "Me." He is inseperable from them. He and they constitute a spiritual duality, a cycle of spiritual power. He goes out to them in His life lived on earth, in the cross of Calvary, in the Gospel, in the messengers whom He sends, in the Holy Spirit who is the living connecting medium

between Himself and the souls of men. These different means of grace are all special phases of the outgoing, self-sacrificing, loving, living power of God to an unsaved world. The world, on the other hand, feels the incoming power, and, as elsewhere stated, is either drawn or repelled. The effect depends upon the attitude of the mind who receives the spiritual influence. Thank God, the hearts of many are turning to the Lord. In response to the outcoming invitation they say: "I will arise and go to my Father." In their aspirations, their hope, their love, their faith, their daily service, their prayers, their whole souls render a joyful response to Him. This cycle of spiritual energy must ever be kept flowing from Christ, the living fountain, if the heart and life of man is to be kept pure and loving, just as the circulation of the blood is essential to the physical life.

In this scientific exposition of Christianity there is outlined what the World Brotherhood is to be, and the means by which it is to be accomplished. The distinctions between Christianity and the ethnic religions also are apparent. There have been prophets, and sages, and religious teachers, who have served their purpose in this great plan of redemption, but none of them are to be compared with Jesus Christ. God did not leave any part of the human race to itself, but in order to lift it up He followed the plan of universal law,

and, in the process of time, provided a Saving, Renewing Nucleus, who could reach out and regenerate the spiritually potential world. The world must be brought up into Christ. Every one who comes into vital fellowship with Him, regardless of denominational connection, is a member of the great Sociological Christian Brotherhood which shall ever increase in numbers and influence while the present order of the world continues.

Chapter XXI

The Biblical Cycle of Creation

In studying the material creation we have traced backwards through nature into Spirit, and forwards, working in nature, the presence and power of a triune God ; and in the Bible, the book of God, the existence and power of the same Three Persons in One God. Nature makes manifest this God working in the physical universe, in a series of creations, always advancing from a lower to a higher order. But the cycle of physical creations culminates in man. Probably the most devout believer in evolution does not look for a higher development of physical being on the earth than man, because the manifestation of mental and spiritual phenomena in man's being precludes the idea of a continuance of the physical evolution. Hence, progress in the physical creation culminates in the midst of the creative cycle, the physical having been superseded by the psychological and spiritual. Consequently the spiritual should continue upwards, in a series of progression, until the entire creative cycle is complete.

The duality which we have seen existing in every system, as belonging to every nucleus and its field, involves the presence of an equality of kinetic and potential forces, and these forces cause energy to move in cycles in every system. We

may observe also that the kinetic and the potential forces are not only equal but that they are directly opposed to each other. And moreover in all physical cycles, near the extremity of the kinetic and the beginning of the potential energy is a point where the new creations are formed.

Now, as in the universe there exist both the physical and the spiritual, any universal cycle of creation should include both elements; and as, in the order of creation, the physical forms the first half of the universal cycle of creative energy, which first half is always the kinetic half of any system, the spiritual must form the second half, which is the potential or passive half as relates to the primary source, or nucleus, of energy. Creative energy has gone out from God and has progressed along the line of the physical, becoming constantly more varied and complex physically until the limit in man's physical constitution has been reached and, here in his highly perfected physical organism the cycle turns Godward as a spiritual energy, which, in the direction of its motion and in its nature is opposed to the physical man.

According to the law governing cycles, just here, at the termination of the physical and the beginning of the spiritual, is where a new creation must take place, which shall be of a higher order than the physical, spiritual in its nature, and form-

ing one progressive link in the universal cycle of creation.

If the Bible is a true revelation from God to men this entire cycle of creation should be revealed in it. The first half should be physical and the second half spiritual; and also the Biblical cycle must agree with the handwriting of God in nature throughout the physical half of the cycle.

Turning now to the Bible and going through it, from cover to cover, a cycle is there revealed of the most marvelous nature conceivable. It is an exact fac-simile of what God in nature has taught should be found in his word. The profound reverence and admiration of God's power and glory and love which have come to us in the discovery of this Bible representation of the universal cycle of creation, in which we are so blessed, is far beyond the power of language to express. The physical half of the cycle is found in Genesis, Chap. I. It comprises six days or periods of time, in which God fashioned the earth and created living things upon it. The spiritual half of the cycle begins with the creation of man in the second Chapter of Genesis and continues to the end of Revelation. This second half, comprising man's moral and spiritual development, in which he is made a new spiritual being, is also divided into six periods of time, each of which represents a different condition of spiritual existence.

The first verse, of the first book of the Bible, says: "In the beginning God created the heavens and the earth." The second verse begins with, "And the earth was waste and void." The first verse is a statement, in one sentence, of the entire work of creation, including the heavens, and also the earth up to a certain stage in its development. The sacred writer does not thereafter refer to the creation of the heavens, as such, but henceforth confines his descriptions to what God did upon the earth. A comparison of geological facts with the Bible reveals a wonderful similarity between the two.

1. He says the earth was waste and void, and dark. Then God's Spirit began to work, dispelled the darkness and brought order out of chaos. Science tells us that the earth was once a molten ball; that when the cooling proce s had progressed somewhat, separation of the gases and solids occurred, and the surface of the earth was enveloped in dense vapors which probably produced complete darkness. Therefore, on this point, science speaks the same that the Bible does.

2. The sacred historian tells us that there was no firmament, implying that the whole earth was enveloped in a dense vapor or mist, no doubt part atmosphere, part vapor of water, and another part other forms of matter, but that God separated these vapors from one another causing one portion

to fall to earth and the other part to rise as clouds in the heavens, thus making a firmament above the earth. Science tells us that as the earth became colder and radiated less heat the atmosphere gradually became more clarified, the denser portions falling again to the earth. Here also science corroborates the story of the Bible. We have all seen even at this late period of the earth's development, times of low pressure when the firmament entirely disappeared and we seemed enveloped in a sea of darkness.

(3) The author of Genesis says that after some of the water previously contained in the atmosphere had fallen to the earth the whole face of the ground was submerged in it. Then God caused the dry land to appear in places, and gathered the waters together into seas. And after that he caused the earth to bring forth grass and herbs, and fruit trees, each bearing seed after its own kind.

This Biblical statement that God caused the earth to bring forth vegetation on the third day of creation is in very remarkable agreement with science. Geology not only tells us that the earth was at one period entirely enveloped in water and that through successive changes dry land appeared, but also it is definite in asserting that vegetation was produced before even the lowest form of animal life was created.

Both in Canada and the United States fossil remains of deep sea vegetation have been found in the Laurentian or gneiss rocks of the Archaean Period before animal fossils appear.

There is good reason to doubt the possibility of the existence of animal life of any form prior to the existence of vegetation. Professor Dyer throws much light upon this subject in the following paragraph:* "The fundamental difference which separates the vegetable kingdom from the animal kingdom is to be found in the modes of nutrition which obtain in each. If we compare a plant and animal reduced to their simplest terms, and consisting, therefore, in each case of a single cell, i. e., of a minute mass of protoplasm invested with a cell-wall, while the unicellular plant draws its nutriment by simple imbibition through the cell-wall from the surrounding medium—a process which implies that all its nutriment passes into it in a liquid form—the unicellular animal is able to take in solid nutriment by means of interruptions in the continuity of the cell-wall, and is also able afterwards to reduce this solid food, if of a suitable composition, to the liquid state. And not merely is there a difference of this kind in the mode, there is also one no less important, though less general, in the materials of nutrition. While under present terrestrial conditions those substances, or chemical combinations, which are

* Enc. Brit. Vol. III, p. 690.

required for the nutrition of animal organisms are, as far as we know, nowhere spontaneously produced—that is to say, nowhere apart from the influence of living organisms—materials derived wholly from the inorganic world are sufficient to sustain directly nearly the whole of vegetable life, and therefore indirectly, of all other life as well. Roughly speaking, while plants are able to use for the purposes of nutrition binary compounds, such as carbon dioxide (CO_2), water (H_2O), and ammonia (NH_3), animals are essentially dependent on the same elements as enter into these compounds, but mostly in a higher state of chemical aggregation than the binary. Plants, therefore, are the 'hewers of wood and drawers of water' for other living things."

(4) Beginning with the 14th verse the writer represents that there is no sun, moon, or stars, and that God made them at this late day in the development of the world, and set them in the heavens to give light upon the earth. Sceptics have scoffed at what is recorded as occurring in the fourth period of time, but they should remember that the writer of Genesis is telling us all the while of what occurred, or of what God did, in the earth, and nowhere after his statement in the first verse, is he saying any thing at all about what was occurring in heaven. So, as a few thousand years ago we left the earth enveloped in a moist

atomsphere with continuous overhanging clouds above the firmament which obscured the sun we now see those clouds being dispelled by changes which are transpiring in the earth; and the sun, moon, and stars, for the first time, being set in the heavens, to give light upon the earth. In this instance, also, the Biblical account is in accord with science.

(5) Now, the sacred writer says that God created swarms of living creatures, first in the sea and then in the air, all manner of fishes and sea-monsters and of winged-birds. Geology says that fishes, amphibia, reptiles, and birds, appeared in the order here given. There is here no discrepancy between geology and the Bible account.

(6) In the sixth period God is represented as creating, or causing the earth to bring forth cattle, creeping, or moving things, and beasts of the earth. Geology says that at this time in the order of evolution the Mammalia appeared. And that at the very end of the evolution of the genera and animal species man appeared away up in the Post Tertiary Period, towards the close of the Glacial epoch in Europe. The Bible says that after God had made the cattle and the beasts of the earth He "Created man in His own image, in the image of God created He him; male and female created He them."

God has worked through six days, long periods of time, and brought the physical creation to a completion. He now rests from the labor which he has been doing and beholds the things he has made, that they are good. After the Sabbath God resumes his work in order to finish the cycle of creation and fulfil his purpose in the full development of the spiritual being of man. Hence, he is introduced to us in the 4th verse of the 2nd chapter of Genesis as Jehovah God—the name of God in his special relation to men as opposed to God as Creator in a general way. After a very brief preliminary statement of the facts of the physical creation culminating in man we are brought to the first of the six days pertaining to God's work for his spiritual creation.

1. Paradise Possessed. In the rock formations of the earth it frequently occurs that the stratum of one period overlaps and mingles with the stratum of another so that it is difficult to decide just where the dividing line is or to which period some of the deposits belong. We find a similar difficulty, in the Bible story, when passing from the physical to the spiritual creation, in determining what is physical and historical and what is spiritual and symbolic. It is quite safe to say that throughout the first day of spiritual creation we encounter an element of the physical and historical, as well as of the

spiritual. It seems probable that the garden of Eden account is a historical fact, but the chief interest attaching to it is not that there was an Eden; it is the fact of Jehovah's care and provision for him whom He had made a "living soul," and the spiritual development of the man to a point where he was able to recognize and appreciate God's provision for him.

There is still further mental growth manifest in man's recognition of the beasts of the field and the birds of the air and in his becoming able to give them names. If Eden is a historical fact, it, and the creation of the beasts and birds, and also of Eve, must belong to the physical creation already finished, because we reached a place on the sixth day of the first week where man and woman were both created. These events are brought over into the first day of the spiritual creation because they are inseparable from man's spiritual development in that period.

There seems to be a special reason for the statement in this connection that "out of the ground Jehovah God formed every beast of the field." It will be remembered that Adam is seeking a help-meet and that Jehovah is leading him in the search. Jehovah intends to supply this need, but He desires to instruct man and lead him up to a stage of intelligence and ex-

perience where he can understand and appreciate the blessing when Jehovah brings him the desire of his heart. So, while the sacred narrator says that Jehovah formed the beasts out of the ground He says also that of "the rib which Jehovah God had taken from the man made He a woman, and brought her unto the man." Here the beasts formed out of the ground and the woman formed out of a rib taken from the man are placed in contrast, in the mind of the first man, and of all future generations of men. Nothing is here said as to when God formed the beasts. We are told about that in the first chapter of Genesis. But to the opening understanding of Adam they came as having recently been formed, and the recognition on his part that they were formed out of the earth, and that Eve was taken out of himself, were very needful psychological experiences. It was needful for him to know that woman was of his flesh and blood and that she sustained a holy relation to him and he to her which neither of them could bear to any of the rest of the animal kingdom. Degenerate man has been too slow to learn that woman is human and divine like himself. She has been thought to have no soul. She has been degraded by men more than the beasts of the earth. The wife has often been more neglected than the dumb brute. The constant association of

animals, fishes, and men in the mythologies and religions of many nations shows that degenerate man does not sufficiently realize the difference there is between the human species and the beasts of the earth.

In this first period, in which man was a living soul he learned two important lessons,—the relations which ought to exist between himself and Jehovah God, and between himself and his wife.

One of the provisions of Paradise belonged almost wholly, if not entirely, to man's spiritual nature. It was the placing of the tree of life and the tree of the knowledge of good and evil in the midst of the garden. Some expositors have supposed that the former had special, perhaps miraculous, healing properties, and that the latter was a variety of poisonous tree, but no one really knows. The truth is that it matters little what kind of trees they were, the real effects lay in the nature of the spiritual and mental attitude of Adam and Eve towards their Maker. Would they trust God and obey him, or would they not? We have already been shown that in the very nature of the spiritual life of man, if it is to develop, it must be passive and obedient in the hands of God. Therefore, the most important question which the Creator must know of his creature man is

whether he will resist the evil and choose the good. And the question upon which depends man's life or death, a question which he must decide for himself, pertains to his moral allegiance to God. It is quite evident, therefore, that the putting of these visible signs in the garden—one of life and the other of death—was an educative measure for the strengthening of man's spiritual personality. They were a visible sign of the dual principles of his nature. Man was made in the image of God but he was without experience and consequently was morally an infant. God meant that he should grow and advance from stature to stature.

2. Paradise Lost and the Promise Gained. Adam and Eve in Paradise were surrounded by every comfort. They had fellowship with Jehovah who himself, or by his representative, communed with them in visible form. They had every reason for implicitly trusting him, and ever before them was the solemn warning of the direful consequences that would follow disobedience. But when tempted, they allowed the thought of disobedience to form in their minds and then the disposition to turn away from Jehovah God.

"Thus was the seal broken, the integrity of the heart was gone, the sin was generated, and the outward act was the confirmation of the dire

process. Eve, less informed, less cautious, less endowed with strength of mind, became the more ready victim. 'The woman being deceived, was in the transgression;' but 'Adam was not deceived' (I Tim. 2-14). He rushed knowingly and deliberately to ruin. The offense had grievous aggravations. It was the preference of a trifling gratification to the approbation of the Supreme Lord of the universe; it implied a denial of the wisdom, holiness, goodness, veracity and power of God; it was marked with extreme ingratitude, and it involved a contemptuous disregard of consequences, awfully impious as it referred to their immediate connection with the moral government of God, and cruelly selfish as it respected their posterity."

The sentence of death pronounced upon them took effect even before they encountered God. Their eyes were opened to see the heinousness of their sin and they beheld their shame. They were afraid and hid themselves Spiritual death had already siezed upon them and physical death could be avoided for a little while only. They had cut the cable which anchored them safely to their Maker and were drifting out to sea, away from God and without hope.

But Jehovah God was very gracious. Though they had sinned he had compassion and taught them how to clothe themselves with the skins of

animals; probably the animals were offered as sacrifices unto God. Moreover Jehovah sent a ray of hope and light into the agonized consciences of Adam and Eve in the latter part of his denuciation upon their cruel seducer. "And I will put enmity between thee and the woman, and between thy seed and her seed: he shall bruise thy head and thou shalt bruise his heel." This is thought by Christian expositors to be the first gospel promise. In it there is a promise of the deliverer who should come and destroy the works of satan and restore to a fallen race that which it had lost through sin. Yea more; the redemption dimly foreshadowed in this promise, through Christ, was much more than humanity had lost through the Fall. It raises man to a height of bliss and glory scarcely conceivable in his primitive state. So, as in other periods of the cycle of creation, although man's part in this period was a degeneration, God's part was a progression from a lower to a higher spiritual perfection.

(3) The Abrahamic Covenant. The reign of death which was particularly marked during the period designated Paradise Lost continued approximately two thousand years, but during this entire time of spiritual darkness God had a chosen seed who served him. Of these the Bible characters specially mentioned are Abel, Seth,

Enoch and Noah. But in the fulness of time, for the realization of his promise to Adam and Eve of giving victory over the serpent, who personifies the devil, Jehovah God ushered in a covenant dispensation through Abraham. This covenant dispensation continued very nearly another two thousand years, embracing the time from Abraham to Christ. It constituted the third day in the spiritual half of the universal cycle of creation. There were special involutions of spiritual energy which marked new eras during this period each one lifting the Hebrews to a higher spiritual elevation than the preceding one. One of these eras was ushered in by Moses, the "Law-giver." At Jehovah's command he not only led the Hebrews from bondage in Egypt to their own land, but he also established a moral code as embodied in the ten commandments, a ritual for the regulation of worship, and rules for the civil administration, the principles of which have since been incorporated into the ethical codes, the religious creeds, and the civil laws of of all enlightened nations of the world.

The establishment of the kingdom under David marks another rise in spiritual greatness and in temporal power. David, a shepherd boy, who, with a sling, slew Goliath the Philistine giant when he defied the armies of Isreal and of the living God, was strong in his faith in Jehovah,

and by Him he conquered. He finally ascended the throne and became a mighty king. He received the promise that his kingdom should endure forever. He also became the "sweet singer of Israel," and his Psalms will be sung by all Christian people till the end of time.

Other great events occurred in the history of the nation and many great prophets arose, but the greatest person of the nation and the greatest that the world has ever known, or ever will know, was Jesus Christ, who was born towards the close of the temporal kingdom of David. The principal object, in the mind of God, in the establishment of this covenant dispensation was the preparation of a people through whom the Savior could come into the world. Abraham was a worshipper of Jehovah, and his descendants, through the ritualistic and sacrificial worship given by Moses and through prophecy, were constantly admonished to expect the coming of the Messiah. The Introductory part of God's covenant with Abraham reads thus: *"Now Jehovah said unto Abram, Get thee out of thy country, and from thy kindred, and from thy father's house, unto the land that I will show thee: and I will make of thee a great nation, and I will bless thee, and make thy name great; and be thou a blessing: and I will bless them that bless thee, and him that curseth thee will I curse: and

* Gen. 12:1

in thee shall all the families of the earth be blessed." On another occasion God said, "In Isaac shall thy seed be called." The promise of blessing previously made to Abram, including the possession of the land of Canaan, was renewed to Isaac and later to Jacob his son and heir, and to his posterity.

Moses the great law giver, and leader of Abraham's descendants, when about to die, prophesied to the nation, saying, * "Jehovah thy God will raise up unto thee a prophet from the midst of thee, of thy brethren, like unto me; unto him ye shall hearken."

Some hundreds of years after Moses, Jehovah, through the mouth of another prophet, exclaimed, † "Behold, my servant, whom I uphold; my chosen, in whom my soul delighteth; I have put my spirit upon him; he will bring forth justice to the Gentiles...He will not fail nor be discouraged, till he have set justice in the earth; and the isles shall wait for his law."

There are more than a hundred prophecies in the Bible which foretell various features connected with the advent and character of the Messiah. The latest prophecies concerning him were uttered probably three hundred years before the birth of the Savior. But, as the years came and went, the time drew near when the Savior should come into the world. Then the angel Gabriel appeared to

* Deut. 18 : 15.
† Isa. 42 : 1, 4.

the virgin Mary, of the house of King David, and said: * "The Holy Spirit shall come upon thee, and the power of the Most High shall overshadow thee: wherefore also the holy thing which is begotten shall be called the Son of God." The Bible teaches, and the Christian Church has maintained since His birth, that Christ was begotten by the Holy Spirit without the intervention of a human father, and we believe that His life, death, resurrection and ascension fully justify such a conclusion.

We do not intend to theorize about this claim concerning the birth of Jesus, but let us examine it carefully from the standpoint of the natural creation. It has been demonstrated that the physical creation advanced from the inorganic to the vegetable, from the vegetable to the animal, and finally from the animal to the spiritual, and that at each successive step in the series of creations the rise from a lower to a higher order of being was made possible only by an involution of power, directly or indirectly, from the Creator. We saw also that in all physical systems the third individuality, or the germinal area, lies in the high pressure point just between the kinetic and the potential forces. It was shown also that in the universal creative cycle the physical creations terminate in the human race and the spiritual part of the cycle, which is opposed to the

* Luke 1:35.

physical, begins there also. According to the universal law of cycles there will be no more development of man's physical nature, but the spiritual must go on developing. That development will be primarily, by a new creation consisting of a physical man having a more highly constituted spiritual personality; and this new spiritual man, according to the evolution of new creations, must come forth out of man, in whom the physical and the spiritual cycle can proceed towards its completion in spiritual development. Again, it must be seen that as the physical has come to its limit in progressive creation, physical parentage for the new man, as to fatherhood, must cease. Consequently the parentage of the to be made spiritual being—the Messiah—who is above the physical man, must be spiritual. That is, his father must be God, who is Spirit. This spiritual germinal personality who came by the overshadowing of the Holy Spirit was none other than the intermediate person of the Trinity, who, being in the bosom of the Father, emptied himself, and, coming down to earth, was made flesh, and became a new physico-spiritual creation. He is the first of a new spiritual race of human beings and the elder brother of all who shall be born after his likeness. Therefore, what many have thought was unnatural and untrustworthy concerning the birth of Christ, was not unnatural

at all; it was only supernatural—a higher exercise of law than what we see in nature.

4. The New Covenant. The Abrahamic Covenant pertained to the promises of the coming and to the birth of one person more spiritual than any other of the human race who should be the representative of mankind in the new and spiritual creation of human beings necessary in the completion of the creative cycle. This representative person, the Savior, having come at the close of the 3rd day in the spiritual creation, the 4th, or New Covenant, period pertains to the restoration of what man lost in the Fall and to the new birth offered the children of men, through Christ, who is the firstborn in the spiritual kingdom.

The kingdom of God is a spiritual kingdom and none but spiritual beings can inhabit it. Christ taught Nicodemus that unless a man be born of the Spirit he could not see the kingdom of God. In Christ's statement to this doctor of the law we see that the evolutionary law that creations progress by successive births from a lower to a higher life, in the cycle of the universe through involution, is operative in the spiritual world as well as in the physical. Consequently man's only hope of entering the kingdom of God is through the spiritual birth.

Birth is never spontaneous, so far as we know, nor does it come through development. It comes

only by parentage, double parentage, that of a father and a mother. And when Christ speaks of our being born of the Spirit he means that we experience a spiritual birth within ourselves, and that this new spiritual personality within us is begotten of God by the Spirit as our Father.

Now whilst Christ is the first born of this new spiritual humanity, and is, in that sense our elder brother, he is, in a very real sense, our spiritual progenitor. We are born of the Spirit in the sense of sonship, and the Spirit, though mostly spoken of as the Spirit of God, is referred to by both Peter and Paul as the Spirit of Christ. And Christ himself speaks of dwelling in us by the Holy Spirit. Therefore, as the Spirit is given by virtue of his sacrifice, and is his Spirit, we can look up to Christ and recognize that on our Father's side our spiritual life comes through him.

On the eve of Christ's crucifixion, at the last supper with his disciples, He taught them that this new covenant was made possible by the shedding of his own blood. There is a divine mystery about the death of Christ for our atonement which is too high for us to comprehend, but we know that it was vicarious. Had it been disobedience requiring only the forgiveness of a Father to a penitent child, I cannot see that any vicarious sacrifice, such as Christ made upon the Cross, would have been necessary ;

but man's sin, in its consequences, entailed more than a need for pardon. The child who has lost his life in the act of disobedience may be forgiven a thousand times, by fond parents whose hearts year over him; yet that forgiveness is unable to restore the life that was lost. It was thus in the heavenly Father's relation to a lost humanity. Their sin had entailed death even before Jehovah passed the sentence upon them, for "The wages of sin is death." Therefore the consideration involved in man's case was this: would, or could, the loving Father devise a means by which we should be restored to life? The primary question was that of restoration to life, which embraced also the secondary question of forgiveness. Now, let us reflect upon how life comes! Throughout the realm of nature life comes only from life. If this is so in the natural world are we not justified in presuming that in the spiritual world also life comes only from life? No one, I think, will raise a protest against such an inference. Again, the nature of man is two-fold—physical and spiritual. His sin entailed death upon his entire being thus intercepting God's plan for our future development and exaltation. Consequently any effectual work of God in our behalf must be such as would restore life to us in our two-fold individuality.

It is not only a universal law that life comes from life but also that new life comes only through

the death of the parent life. Every vegetable or animal cell which sends out a new germ-cell, and every plant or animal which gives life to a new organism, itself dies, to the extent of the new life-energy embodied in such new organism. Therefore God, in giving new life to a dying race accomplished it through death. God in Christ, to the extent necessary for the restoration to life of all the world of men from the biginning to the end of time, suffered and died that we might live. The Christian Church has been prone to look upon the agony of the cross as embracing the whole of the act of reconciliation, but it appears to me that such a view is superficial, and does not fully meet the needs of the case. God, in the universe, works by slow processes. A thousand years with Him are as one day. In the realms of astronomy, geology, biology, sociology, psychology, ethics, He has worked age after age creating and developing the different orders of existences, and shall we not likewise suppose that He has given Himself time in providing a sacrifice for our redemption? Both science and revelation seem to support such an idea. Peter tells us that Christ in reference to His sacrificial work "Was foreknown indeed before the foundation of the world!" And John, in the Revelation, speaks of Him as "The Lamb that was slain from the foundation of the world."

Moreover, there are many passages of Scripture which show that from the first sin of man Christ was working in the world for our salvation, and was indeed always giving life to fallen man on condition of faith and repentance. Now if Christ was slain from the beginning of time, and if He was always exercising Himself for our sakes in the consummation of the Great Sacrifice, He surely must, from the first, have entered into the sufferings which led up to the climax on the cross. According to the law of life one of the principal causes of death is a failure of the potential forces of a living organism to rapair the loss sustained by kinetic action. This is especially true in the case of too much strain on the system through reproduction of life, the potential forces being exhausted on the new life. Hence, if Christ's sacrificial work for us was an actual giving of Himself, of His life, that we might live, and if that sacrificial work was, even in a small degree, effectual in bringing life to the human race before His incarnation, then He must have already entered the road to suffering and death before His work began: and He was already giving His life, divesting Himself of His glory in the bestowment of life upon us, throughout the ages. The climax of this Sacrifice was the incarnation, and the very dregs of the bitter cup were the cross. Thus the Savior

was divested of the glory, the fulness of life, which He had with the Father before the world was, because He gave His life for us, and this, not so much to satisfy a broken law as that He might bring life and immortality to light through the Gospel. But though Christ died, humanly speaking, He could not be holden of death; He yet lived, and the cup of anguish having been drunk dry He changed the forces of life and death, the former now having conquered the latter, and came forth from the tomb. With His rising from the grave in a purified and glorified human nature He brought up with Himself the whole human family. But His sufferings for us are not yet complete. They can only be finished when the last soul on earth, to the end of time, has received the offer of that life which was lost through sin, and when the entire work of saving men shall have been finished. The Spirit yet maketh intercession for us with groanings which cannot be uttered. He has given life freely, without reserve, to all men. But sad though it is, some men, by rejecting the love which bestowed life at so dear a cost bring upon themselves the "second death," which is even more awful than the death following the first entrance of sin into the world. The sacrificial work was done for us, without us; but, as previously clearly shown, the manner of our receiving the

new life is necessarily through the process of a new birth. It is spiritual life, begotten of the Spirit, within the human soul. Such a birth, by the law of life, is possible only through action and reaction. The action is from Christ and the reaction is from us. The current of life comes knocking at the door of the heart for admittance. If the heart is closed, and kept closed, that person remains barren of the life which Christ offers. If the heart responds, and the door is opened, Christ comes in and a new life is begotten.

God's work in preparing the Great Sacrifice was a work requiring time, and so the begetting of a new germinal life in the soul requires time for growth from infancy to maturity. The germ-life is completed within the period of the earthly life, but the perfected life includes the lifting of the mortal body of the soul from its mortality into a spiritual, immortal existence, which cannot be consummated until the day appointed, when death shall be wholly swallowed up in victory.

5. The Millennial Reign. The 4th day of the spiritual creation will be succeeded by the Millennial Reign of Christ. During the preceding period he raised believing man to the elevated position of sonship. Now he comes and with a special display of power re-establishes his kingdom among men. From what the Bible says about

this reign and Jesus' second coming it seems that this will be a personal reign by his presence here on earth. The beginning of this period is to be marked by the binding of satan, and an outpouring of great spiritual power upon mankind, a special feature of which will be the resurrection of those who * "had been beheaded for the testimony of Jesus, and for the word of God, and such as worshipped not the beast, neither his image, and received not the mark upon their forehead and upon their hand." These shall live and reign with Christ a thousand years. This may mean an exact thousand years, or the number may stand for a long and indefinite period. This millennial period described in Rev. 20 is yet future. There have been many speculations about it, but it does not come within the purpose of this book to advance any theories on the subject. It is the Day prophesied of by Isaiah, when he said,† "And it shall come to pass in the last days, that the mountain of the Lord's house shall be established in the top of the mountains, and shall be exalted above the hills; and all nations shall flow unto it. And many people shall go and say, Come ye, and let us go up to the mountain of the Lord, the house of the God of Jacob; and he will teach us of his ways, and we will walk in his paths: for out of Zion shall go forth the law, and the word

* Revelation XX, 4.
† Isa. II, 2—4.

of the Lord from Jerusalem. And he will judge between the nations, and shall rebuke many peoples; and they shall beat their swords into plowshares, and their spears into pruning-hooks; nation shall not lift up sword against nation, neither shall they learn war any more." Christ's reign will be characterized by peace and righteousness. At that time the nations of the earth will have attained a much higher state of piety and knowledge than what they now possess. This high state of spiritual development will have been reached through the fifth and special dispensation of Jehovah's grace to man. Man is able to profit by these dispensations of blessing, however, only through his acceptance of God's mercy to him through Jesus Christ. During these thousand years Christ will reign supreme over the earth.

6. The New Heaven and the New Earth. The millennium will be succeeded by the sixth and final day's work of the spiritual creation. As a preliminary work Christ will sit upon the throne and before Him will be gathered all nations unto the judgment The sea and the grave will give up their dead, and each person will be judged out of the books which shall be opened. Those whose names are not written in the "book of life" will be cast into the "lake of fire."

It required age after age, creation after creation, to bring man through the physical changes and on up through the spiritual and psychological creations to the sixth day of his spiritual existence. If now, after all this expenditure of energy upon him, and love for him, he is found unfit for the presence of his Maker there remains nothing for him but to be turned away.

But we must turn from the dark side of Man's spiritual nature to the glorious condition of those who are found fit for the new heavens and the new earth. In the resurrection which will be after the manner of Christ's glorious resurrection, the old nature, the old world, and all things which harm and give pain, are passed away and there is a new and beautiful city of which Jesus is the light and the glory. This city is called the "New Jerusalem."

From mortal sinful beings we have become immortal sinless beings worthy of the society of heaven. What else of God's grace may be in store for us we do not know, but only that throughout eternity we shall be with Jesus and be like Him. No language could exceed the beauty and the sweetness of the description which the Apostle John gives of this glorious city and the redeemed who inherit it.

"And I saw a new heaven and a new earth; for the first heaven and the first earth are passed

away; and the sea is no more. And I saw the Holy City, New Jerusalem, coming down out of heaven from God, made ready as a bride adorned for her husband. And I heard a great voice out of the throne saying, Behold the tabernacle of God is with men, and he shall dwell with them, and they shall be his peoples, and God himself shall be with them, and be their God: and he shall wipe away every tear from their eyes; and death shall be no more; neither shall there be mourning, nor crying, nor pain any more, the first things are passed away." "And the city hath no need of the sun, neither of the moon, to shine upon it: for the glory of God did lighten it, and the lamp thereof is the Lamb. And the nations shall walk amidst the light thereof and the kings of the earth bring their glory into it ..... And there shall in no wise enter into it anything unclean, or he that maketh an abomination and a lie; but only they that are written in the Lamb's book of life."

In coming to the close of this day's work, the last in the universal cycle of creation, our task is finished, but we cannot lay down our pen after months and years of toil in an endeavor to find one God in nature and in revelation without saying that we feel amply rewarded for the efforts made. Nature has led us up to God by interpreting the meaning of his word to us.

But what nature could not do in completing the creative cycle, God's word has done. It has made the entire cycle of creation so plain that no one should ever again doubt.

The book of Genesis is one of the oldest, if not the oldest work of literature in the world. It was written at a time when men knew very little of any science, and when they knew nothing at all about geology to which we are indebted for most of our knowledge of the age of the earth and the successive epochs when organic life appeared. A careful comparison of the records of the rocks as to the creation of the earth and its living inhabitants of the present and the past, with the first few pages of Genesis, reveals to us the marvelous fact that in every instance where both speak on identical subjects they corroborate each others's statements. There is not a single discrepancy. It is doubtful if any man to-day, with all of our knowledge of the sciences, could tell the story of creation so accurately and in so few words, as is done in the Bible account. Whence then, did the writer get this wonderful knowledge? It did not come by learning. Did he obtain it in myth? No! Mythology is never true. Did he find it in tradition? Some persons think so! There are stories of creation among the ancient people from which Abraham came that some-

what resemble the Bible narrative, but none are like it. Suppose, however, that the very same narrative should be found to have existed hundreds or thousands of years before the time when Moses wrote Genesis, the question still remains, "Where did the one who first wrote it get it?" The narrative speaks almost exclusively of events which happened hundreds and thousands of years before the creation of man, and yet, he writes of their occurrence as truthfully and explicitly as if he had been an eye-witness to them all. There was no means within the reach of primitive man by which he could have acquired such marvelous truth, except that of spiritual involution. It may have come as a dream, or in a vision, or by some manifestation in personal form as of an angel, or it may have been imparted to his mind by direct revelation, but in whatever form it came it was an impartation of spiritual energy and knowledge from God.

As in geology there was formed tier upon tier of rocks throughout the periods of evolution so in the spiritual creation of man there are strata of rocks as immovable and real as the solid granite of the earth. Each stratum presents a decidedly different formation from any of the others, and as we dig down from the higher into the lower we find each stratum clearly delimited, and in

the strata of these eternal rocks there is visible the purpose and the wisdom of Jehovah as He worked from age to age in the creation and the perfection of the human race.

Nothing in the universe is more wonderful than the relation of the cross to these rock foundations. The reader may have thought of the cross as having stood only a few feet deep in the soil of calvary, but such is not the case.

In the first and oldest rocks, those of the Paradise Possessed period, there is no trace of sin nor of the cross. In the rocks of the Second Day, the Paradise Lost period, there are fossil remains showing degeneration and death. But there are also remains of something else. Here, in a deep excavation in the rock at the very lowest edge of this stratum there is a fossil resembling the shadow of a cross buried ages ago. It is the promise; "I will put enmity between thee and the woman, and between thy seed and her seed; he shall bruise thy head, and thou shalt bruise his heel." Higher up in the same stratum we find another fossil of the cross in the acceptance, by Jehovah, of Abel's offering which consisted in the shedding of blood, while He rejected Cain's offering which was of the fruit of the ground. And above this, still in the same period, there is a fossil still more significant in the altar of Noah for the offering of burnt offerings,

after he came out of the ark, in the approval he received from Jehovah. Then from the time of Abraham and especially of Moses, these fossils become more numerous and distinct in the Abrahamic Covenant period. So, the cross rises and expands upwards through the several strata of rocks until it stands out above Calvary bearing the Lord Jesus. It does not rise much above the top of the Third Stratum of Rocks, but we see Him whom it bore to His tomb rising from the grave up into the rocks of the 4th day, and standing above the cross a living Christ. He has conquered. Hear Him say: "Upon this rock I will build my church." Consequently Paul says: "Other foundations can no man lay than that is laid, which is Jesus Christ." He is present all the way on up through the New Covenant period. He is the "Light of the World." At the beginning of the 4th day of the physical creation, the great luminary, the sun, was set in the heavens to give light upon the earth, and at the beginning of the 4th day in the spiritual creation Christ was lifted up as the great light of the spiritual world.

To-day, through Him, the nations are living in a higher realm than they have before known. We, his children, are "making footprints in the sands of time" which will in future generations become solid rock, and some day the spiritual

archaeologist will make excavations in these long buried stones and find the footprints we are now making. In the rocks of the 5th day, the Millennial period, also Jesus is the central personage. He is the ruler of the nations and all men bow to and serve Him On the 6th day, the New Heaven and the New Earth Period, Jesus is the light of the New Jerusalem, the holy city. The cross is planted down in the rocks as deep as man's need; and the Christ of the cross has risen as high as the utmost bounds of man's hopes and aspirations. The rock foundations of the ages of man's spiritual evolution cannot crumble; though rent by earthquakes they can never pull apart or slip one from another and leave man helpless, because they are firmly bound together by Christ and His cross. Herein is man complete in God, and God is all in all in the universe.

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